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VOLUME 110(1): APRIL 2013

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CONTENTS

EDITORIAL 1

LION AND CHEETAH IN INDIA: A CRITIQUE
Divyabhanusinh and M.K. Ranjitsinh 3

BEHAVIOURAL ETHOGRAM OF THE GREAT INDIAN BUSTARD *ARDEOTIS NIGRICEPS* (VIGORS 1831)
Pramod Patil, Asad R. Rahmani and Sara Hallager 22

BIRD RECORDS FROM TAWANG DISTRICT, ARUNACHAL PRADESH, INDIA
Gopinathan Maheswaran 35

DIVERSITY AND DISTRIBUTION OF ACRIDID PESTS (ORTHOPTERA: ACRIDIDAE) OF PURVANCHAL REGION, UTTAR PRADESH, INDIA
Uzma Rafi and Mohd Kamil Usmani 50

FLORISTIC DIVERSITY OF THE KUNJAPURI SACRED GROVE, GARHWAL HIMALAYA, INDIA
Megha Rawat, H.B. Vasistha, R.K. Manhas and Mridula Negi 57

NEW DESCRIPTION

A NEW SPECIES OF *NOTASPIDIELLA* BOUČEK (HYMENOPTERA: CHALCIDIDAE) WITH A KEY TO SPECIES AND NOTES ON KNOWN SPECIES
T.C. Narendran, Abhilash Peter, K. Nikhil and Minu Mohan 65

MISCELLANEOUS NOTES

MAMMALS

1. First photographic record of the Indian Mouse Deer *Moschiola indica* in Kanha Tiger Reserve, confirming its occurrence in Central India
Ujjwal Kumar, Neha Awasthi, Anup Pradhan, Qamar Qureshi and Y.V. Jhala 71

2. Status of Irrawaddy Dolphin *Orcaella brevirostris* Gray, 1866 and Ganges River Dolphin *Platanista gangetica* Roxburgh, 1801 in the water channels of Sundarban Tiger Reserve, India
Manas P. Manjrekar and Charles Leo Prabu 72

BIRDS

3. Nesting of the White-rumped Vulture *Gyps bengalensis* in Orchha Wildlife Sanctuary, Madhya Pradesh, India
Aditya Roy and Kartik Shastri 74

4. Record of the Bridled Tern *Sterna anaethetus* in Ahmedabad, Gujarat, India
Yasser Rafique 75

5. Record of Sooty Tern *Sterna fuscata* in Pune, Maharashtra, India
Vikram Potdar 75

6. First record of the Blue-and-White Flycatcher *Cyanoptila cyanomelana* in India
Pravin Kawale 75

7. Sighting of Jerdon's Bushchat *Saxicola jerdoni* in Pilibhit, Uttar Pradesh, India
Kaajal Dasgupta 76

8. Second record of the Tricolored Munia *Lonchura malacca* from southern Rajasthan, India
Chhaya Bhatnagar, Deependra Singh Shekhawat and Vijay Kumar Koli 77

AMPHIBIANS

9. Catalogue of Salamander and Newt (Amphibia: Urodela/Caudata) specimens in the collection of the Zoological Survey of India
Kaushik Deuti and P.G.S. Sethy 78

FISH

10. Sexual dimorphism in *Hypselobarbus kurali* (Pisces: Cyprinidae)
E. Sherly Williams, J. Jean Jose, P.V. Vijayalakshmi, L. Razeena Karim and M.S. Vishnu Nair 82

OTHER INVERTEBRATES

11. Observation on a collection of Tawny Coster *Acraea terpsicore* (Pieridae: Lepidoptera) in the web of the Social Spider *Stegodyphus sarasinorum* (Eresidae: Araneae)
Niyati S. Patel 83

12. *Heteropoda fischeri* Jäger, 2005: A Huntsman spider hunting on fellow cavernicoles in the caves of Meghalaya, India
Jayant Biswas and Siddharth Biswas 84

BOTANY

13. A step further to the correct identification of *Ceropegia bulbosa* Roxb. in Kachchh, Gujarat, India
A.R. Badheka, M.J. Parmar and Y.T. Jasrai 85

14. An annual flowering population of Neelakurinji *Strobilanthes kunthianus* (Nees) T. Anders. – A plietesial species from the Nilgiri sholas, India
Franklin Charles Jose 87

15. Rediscovery of *Cinnamomum travancoricum* Gamble (Lauraceae) from the Southern Western Ghats, India
M.P. Geetha Kumary, A.G. Pandurangan and E.S. Santhosh Kumar 89

16. Two new records of mosses for the Indian mainland from the Agasthyamalai Biosphere Reserve in the Western Ghats, India
A.E.D. Daniels and J.L. Mabel 90

Cover Photograph: Lion *Panthera leo*
By Y.V. Jhala

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Editorial

Our neglected sanctuaries

Among the 645 odd protected areas of India, only a few are well-known and regularly highlighted, namely those that have large mega-vertebrates and/or high profile visitors. Even amongst them, tiger reserves receive most of the funding. The rest remain in neglect and oblivion, except perhaps those that are locally known. These neglected Protected Areas (PAs) are generally resented by politicians, administrators, and villagers due to the restrictions placed on extraction of natural resources from them. They are also under-staffed and under-funded. They come to the attention of the Ministry of Environment and Forests, Government of India, and the National Board for Wildlife, dominated by the tiger lobby, only when a forest village road has to be repaired or a pipeline has to be laid! The media pays attention only when a villager is killed by a predator, or poachers are caught.

India has signed the Convention of Biological Diversity and we have the Indian Wildlife Protection Act, but we forget that biological diversity/wildlife also resides beyond the few well-known tiger reserves and national parks, and even outside PAs. Sometimes higher biodiversity is found outside PAs. There are numerous examples from all over India, but I will restrict this editorial to PAs that I happen to visit.

In Uttar Pradesh, Dudhwa National Park is well-known and regularly highlighted by the government and media. Not many know that there is an equally, or possibly, a more ecologically diverse sanctuary called Katerniaghat that was once connected with the Dudhwa forest – a tenuous nocturnal corridor still exists for some animals. Katerniaghat has all the habitat types that Dudhwa has, and the large, meandering Girwa river which hosts the Gangetic Dolphin, Gharial, and river-island breeding birds that Dudhwa does not have. With the addition of a 10 sq. km former seed farm, Katerniaghat can now boast of a large grassland that is a potential habitat for the critically endangered Bengal Florican. Its Swamp Deer population is reviving, thanks to good protection in recent years. As far as birdlife is concerned, Katerniaghat perhaps has more bird species than Dudhwa. The same can be said of reptile, fish, amphibian, and plant taxa. Similarly, the adjoining Suhelwa Wildlife Sanctuary on the Indo-Nepal border perhaps represents the best *bhabhar* forest left in Uttar Pradesh. This 80 km long and 4 to 7 km wide sanctuary is even more neglected than Katerniaghat. One reason: absence of the glamorous big cat! If given enough administrative attention and funds, Suhelwa can be revived and can become a major tourist attraction in this poor part of the state. Its colonial era rest houses, nestled amongst thick forests, can also revive one's nerves, which are battered by living in over-crowded, polluted cities.

In Assam, most people do not think beyond Kaziranga and Manas. Most tourist brochures of the Assam government mention only Kaziranga, it is as if the natural world does not exist beyond this World Heritage Site. No doubt, Kaziranga is marvellous; thanks to good protection for the last 100 years, but Assam has other magnificent sanctuaries. For instance, Dibru-Saikhowa National Park is perhaps as good as Kaziranga and at one time had all the animals that Kaziranga can boast of. But Dibru-Saikhowa is a neglected national park, ravaged by ever-increasing human encroachment and it has a pathetically under-staffed forest force. Dibru-Saikhowa lost its rhinos decades ago, and now the Bengal Florican is on verge of local extinction. The White-winged Duck survives in a few undisturbed forest pools, while the Black-breasted Parrotbill barely exists in the Park as its grassland habitat is almost gone. The most unfortunate part is that the floodplain grasslands that have some of the most threatened bird species of India are overlooked even by the forest authorities. The famous Amarpur grassland of Dibru-Saikhowa is now dotted by cattle herders, leaving very little habitat for grassland-dependent species.

Laokhowa and Bura Chapori sanctuaries of Assam face a similar fate as Dibru-Saikhowa. Laokhowa Wildlife Sanctuary (7,011 ha), located in Nagaon district, was declared as a game reserve way back in 1907 because of its population of Indian One-horned Rhinoceros. Bura Chapori Wildlife Sanctuary (4,406 ha) is contiguous with Laokhowa, and is located on the southern bank of the Brahmaputra. During summer, Bura Chapori virtually becomes an island. Both Laokhowa and Bura Chapori are on the floodplains of the Brahmaputra. In Bura Chapori, about 20% is forest, 65% grassland, and the rest waterbodies and scrub forest. Laokhowa is similar to Kaziranga in terrain and situated further downstream on the southern bank of the Brahmaputra. Roughly 35% of Laokhowa is grassland, 30% comprise of wetlands, and the remaining area is under natural forest or plantations of *Bombax ceiba*, *Dalbergia sissoo*, and *Albizzia procera*. Marasuti, a tributary of the Brahmaputra, flows along the north-western part of the Sanctuary.

The Laokhowa-Bura Chapori complex was recognised as an Important Bird Area in 2004 by BNHS and BirdLife International due to the presence of 16 globally threatened bird species. Laokhowa-Bura Chapori continues to be one of the important potential habitats of the Indian One-horned Rhinoceros. Laokhowa had about 60 rhinos before they were killed in the 1970s, and finally exterminated during the political upheaval in the 1980s. Even now, rhinos appear occasionally after the rains, but they become victims of poachers. Nevertheless, the situation can be improved with strict management, and rhinos can be reintroduced as the habitat is still extant. Elephants are still found here, resulting in human-animal conflict as a large number of villages surround the forests and grasslands. The Wild Buffalo population is cross-bred with domestic buffalo thanks to numerous *khuti*es (cattle sheds) scattered in the Sanctuary. These sanctuaries have great potential to become excellent habitats for the fauna of the Brahmaputra floodplain grasslands, much like the famous Kaziranga. The only step required is to follow the Wildlife Protection Act, under which these two sanctuaries were declared. There is urgent need to clear all encroachments and stop illegal activities.

Similar examples can be given for Rajasthan (and all other states of India). When we think of wildlife of Rajasthan, automatically the wetland birds of Keoladeo National Park, the tigers of Ranthambhore and Sariska come to mind. These over-crowded and over-rated PAs are in every brochure and tourist advertisement. Numerous articles and many books have been written on them. How many people know that Rajasthan wildlife goes beyond Ranthambhore and Keoladeo. The magnificent Desert National Park, home to the largest number of critically endangered Great Indian Bustard, the State Bird of Rajasthan, has been neglected since the establishment of the Park in the 1980s. It does not have sufficient staff to look after this sprawling 3,162 sq. km area. In the ancient Aravalli mountains, Kumbhalgarh, Sitamata, and Phulwari-ki-Naal sanctuaries are waiting for attention. They perhaps represent the best forest types that are now left on these geologically important mountains, but who cares when you do not have large glamorous felines!

Incidentally, we talk of biodiversity conservation ad nauseum, and have made a strong National Biodiversity Act to protect India's natural biological wealth, but when it comes to protecting neglected sanctuaries, neglected ecosystems (e.g. grasslands and mudflats), and neglected species, funds suddenly become a problem. More than lack of funds, it is administrative neglect that is killing these biodiversity hotspots. The earlier we come out of this attitude, the better it would be for all biodiversity, all habitats, and all ecosystems.

Asad R. Rahmani

LION AND CHEETAH IN INDIA: A CRITIQUE

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The book propounds a theory that both the lion and the cheetah were exotic aliens on the Indian subcontinent, as they were imported by humans from Africa in the historical past. The book, however, makes assumptions but fails to provide any valid proof for the theory, which palpably panders to the authors' preconceived notions. This critique challenges this theory on the basis of paleontological finds of lion and cheetah remains and cave paintings of the chalcolithic/neolithic period. Subsequent historical records and current genetic studies of Asiatic lions establish that they are nearer to North African lions than to those of East Africa, from where they were purported to have been imported, and that the cheetah of Iran are a distinct subspecies from those of Africa, but closest to the North African cline of cheetah, which also conclusively proves the surmise of import and introduction of these species by humans to be baseless, and confirms that the lion and cheetah did move out of Africa on the Africa–West Asia land bridge and then into India, like so many other mammals.

Key words: Lion, cheetah, exotic, alien, impostor, mongrel, "*khichdi*"

The authors of this paper have been asked to comment on an interesting theory propounded in a recently published book that the lion and the cheetah are 'exotic aliens' in India. The said publication is *Exotic Aliens: The Lion and The Cheetah in India*, Aleph, New Delhi, 2013, pp. 304, Rs. 595. Its authors are Valmik Thapar, known for his numerous publications on the tiger, Professor Romila Thapar, a doyenne amongst Indian historians, and Yusuf Ansari, also a historian.

At the outset, it would be imperative to examine the implications of the words 'exotic' and 'alien'. The word 'exotic' according to *The Shorter Oxford Dictionary* and *The New Webster's Dictionary* means, 'Alien; introduced from abroad… a plant or animal of foreign extraction...'; 'not fully naturalized or acclimatized'. The word 'alien' implies, inter alia, 'Foreign in nature, character or origin…'; 'Not a citizen or entitled to the privileges of a citizen'. The two words are, therefore, somewhat interchangeable and the use of both in tandem is apparently to give emphasis to the alleged foreign origin of the two cats in question: the lion and the cheetah. Valmik Thapar also calls the lion an 'imposter' in the land of the tiger. *The Shorter Oxford Dictionary* defines the word 'impostor' as 'one who imposes on others, a deceiver, a swindler, cheat… one who passes himself as someone other than he is'.

It is an accepted fact in both history and natural history that many of the more than 500 mammalian species found in India, including humans, have come from outside of the Indian subcontinent. The lion, the cheetah, the oryx, the ostrich, and a host of others came into Asia from Africa; the tiger, the gaur, the serow *Capricornis sumatrensis* and numerous others moved into India from other parts of Asia itself. The title and the theme of the book under review raises two pertinent questions. Firstly, does an alien/exotic species always remain alien/exotic, or does it ever 'get naturalized/become indigenous' and if so, what would be the criteria/period of residence in India for the species to be deemed Indian and non-alien/non-exotic? Secondly, does the title exotic and alien have derogatory or priority implications, and if so, does a species which has come to India earlier have a precedence or priority over another which came later? If that be the case, then species which, indeed, did evolve in the Indian subcontinent such as the nilgai *Boselaphus tragocamelus*, the blackbuck *Antilope cervicapra*, and the unique four-horned antelope *Tetracerus quadricornis*, should take precedence over both the tiger and the lion, and if it can be proved that the lion came into India prior to the tiger, would it be less exotic/alien than the latter and hence more important? Are we to reduce natural history to a parochial farce?

The tiger too evolved in northern Asia and came to India. Does that make it an alien? Why is the book silent on the evolution and arrival of the tiger in India?

As the eminent palaeontologist Dr. G.L. Badam says, "…most of the larger animals migrated from Egypt, Arabia, Central Asia and North America on routes across Alaska, Siberia and Mongolia… Between India and Africa the interchange of faunas took place more easily. There is sufficient evidence for the existence of a land bridge across the straits at the entrance to the Persian Gulf. A corresponding bridge across the Red Sea would have provided a ready means of communication between India and Africa through Arabia." (Badam pers. comm. 2013) Both the lion and the cheetah evolved in southern Africa, and considerable time elapsed by the time they reached northern Africa. This is proven by the genetic differences between the lion and cheetah of southern and northern Africa, as will be mentioned later. The animals then moved out of the land bridge of the Sinai Peninsula and occupied Mesopotamia and neighbouring lands, including Iran, from where they moved westwards into the Indian subcontinent and elsewhere. The ecological and chronological separation has resulted, therefore, in both the Asiatic lion and the Asiatic cheetah being morphologically closer to their North African counterparts than their southern and East African ones. Both the lion and the cheetah are the inhabitants of grasslands and open forests, which were prevalent in western, north-western and central India and which, being suitable habitats of these two species, were occupied by them when they moved into the Indian subcontinent on their westward march from Iran. According to the noted scientist Dr. Y.V. Jhala, species normally achieve their highest densities in the central portion of their distribution range. The Indian subcontinent being at the extreme distributional end of their faunal range that originated from Africa, it is likely that the cheetah and the lion did not attain a high degree of abundance in India (Jhala pers. comm. 2013).

The earliest civilizations that practiced agriculture – Harappan and the Vedic – occupied and cultivated the same short grasslands and open forest areas of western and north-western portions of the Subcontinent, shrinking the habitat of the cheetah and of the lion, and their prey. With the spread of civilization and its attendant increase of agriculture and demographic pressures, especially after the establishment of the Mughal Empire from the 16th century onwards and the relative peace that ensued, together with considerably increased hunting pressure, both these predators and their prey suffered a drastic decline. Lions were a threat to man and livestock and living in relatively open countryside, both the lion and the cheetah could be easily seen and pursued, unlike the leopard and the tiger. By the time the British hunters came to record their exploits in the early decades of the 19th century, the distribution of both the cheetah and lion had been reduced to a handful of isolated enclaves and their numbers were perilously low.

The lion occurred in Iran (Persia) till the middle of the last century and the cheetah still survives in that country. It has never been suggested, not even by the authors of the book in question, that the lion and the cheetah were introduced there by some bygone monarch. These species obviously emanated from Africa. The earliest known hunting record, of the great Egyptian Pharaoh Ahmenhotep III (1406–1370 BCE), mentions his having killed a hundred lions in the first ten years of his reign, between the Nile and the Euphrates (Guggisberg 1962, p.159). The Arabian Oryx *Oryx leucoryx,* recently rendered extinct in the wild, was reintroduced into the Arabian Peninsula from captive populations. The Arabian Ostrich *Struthio camelus syriacus* made extinct in the last century, had its counterpart in India, as is proved by the prehistoric paintings in the Adamgarh rock shelter near Hoshangabad in Madhya Pradesh and by the discovery of ostrich egg shells in over 30 sites in India (Chakravarty 1984, pp. 266–67). On the other hand, the wild equids for which Africa is so famous, evolved in North America and crossed over not only into north-eastern Asia, but eventually also into Africa over the same land bridge of the Sinai (Denzau and Denzau 1999, p. 12). The Arabian Tahr *Arabitragus jayakari*, a totally montane species, has its nearest relatives, the Aoudad *Ammotragus lervia* occurring in the mountains of North Africa and the Himalayan Tahr *Hemitragus jemlahicus* of the Himalaya, living thousands of kilometres away. If we can accept the natural occurrence of the lion and the cheetah in western Iran and indeed, the reports of cheetah occurring in Baluchistan in recent times (Divyabhanusinh 2006, pp. 195–197), and the fact that a single species of a small nocturnal mammal like the Ratel *Mellivora capensis* can live all the way from South Africa to South India, should there be a mental embargo on the acceptance of the natural 'invasion' of the far more free-ranging lion and of the cheetah into India, when there is so much empirical evidence to support it? Even the authors of the book do not suggest that the lion and the cheetah which they claim became feral in India, then spread to Iran and westwards.

It would be appropriate for the reader to see some of the excerpts of the text in support of the theme of the book, followed by our comments. In the Prologue of the book, commenting on Dunbar Brander's statement that only three cheetahs were procured in the last 20 years in Central India and that the animal had almost entirely disappeared from the province, Valmik Thapar says, "It is likely that what Brander referred to must have been three trained cheetahs imported from Africa." Is there any basis of proof or is it just a mere guess? He goes on to state, "Be that as it may, I believe the cheetah in India has been imported from other countries." Which countries and when? For the lion, he says, "What I believe … is that lions from Persia and Africa were being imported into the country [India] 2,500 years ago [and then on] to meet the demand of Indian royals, and being bred and propagated as court symbols and for hunting; this imported animal was erroneously called the Asiatic lion. The story of the cheetah is much the same but its inability to breed in captivity meant that many more had to be imported. Both the species in India were genetic mixtures of animals brought in from elsewhere, and their own inbreeding. Their genetic makeup can be best described as a *khichdi* of genes." On what evidence is this assumption of import and captive breeding made? The author rightly admits that cheetahs are very poor breeders in captivity and therefore suggests that a much larger number had to be imported. But not an iota of evidence of import is ever cited. Jahangir mentions that Akbar had 1,000 cheetahs in captivity at one time. As it would be difficult to say without any proof that 1,000 cheetahs could be imported in Akbar's era, the book resorts to claiming that Akbar's chroniclers and Jahangir were liars. Valmik Thapar goes on to say in the Prologue: "I believe that the lion came to India just before or with Alexander's invasion of India around the third or fourth century BCE. It was from this time onwards that lions were bred, either in designated hunting parks or royal zoos, just like the Gir lion was bred in the late nineteenth century." Which contemporary chronicler or even a later one mentions Alexander bringing over the lion from Persia to India, let alone releasing them in this country? The erudite book *Alexander the Great and the Logistics of the Macedonian Army* states that '… the Macedonian army [was] the fastest, lightest and most mobile force in existence ... Even when the size of his army increased, Alexander took great pains to retain its lightness and mobility by destroying wagons and excess baggage and by eliminating followers. Only horses, mules, and camels were used in Alexander's baggage train because they have greater speed and endurance than oxen or donkeys.' (Engels 1978, p. 23) Would such a lean and peripatetic army transport lions? Since Alexander was not carrying wagons, lions could not have come in cages. Did they arrive on horseback?

Which original source mentions that imported lions were bred in captivity by the monarchs of India prior to the 19th century? As for the statement that the Gir lion was bred in captivity in the 19th century, it is another assumption without the citing of any evidence whatsoever. We are familiar with the conservation and captive breeding of the Gir lion from the 19th century onwards and can categorically state that though the Gir lion was bred in the Sakkarbaug Zoo in Junagadh and elsewhere for zoological purposes, not a single captive-bred lion was introduced into the wild, nor is there any record of a lion escaping from captivity and establishing itself in the wild.

Valmik Thapar quotes Laszlo Bartosiewicz that "Craniological traits of the now extinct North African Barbary lion (*Panthera leo leo* Linnaeus, 1758) and Asiatic lion (*Panthera leo persica* Meyer, 1826) are very similar. There must have been a contiguous population inhabiting North Africa and Asia." Of course there was such a contiguous population linking the North African lion with the Asian one, as mentioned earlier. Are we to presume that the lion colonization westwards stopped on the borders of Iran, despite all the evidence there is to the contrary, because some of us wish it that way?

Valmik Thapar goes on to say "I think it is extremely unlikely that a genetically distinctive subspecies could have existed in the subcontinent… I believe there was never an "Asiatic" cheetah… that the Indian (or Asiatic) lion and the Indian (or Asiatic) cheetah are not distinctive subspecies but are exotic aliens that live (or lived) in the land of the tiger… Till the end of the nineteenth century, there were more lions seen in royal menageries than in the wild and hundreds (if not thousands) of cheetahs on leashes were recorded as being readied for coursing on bullock carts, but not even a handful were encountered in the wild… I believe that, in the absence of wild populations, hundreds of cheetahs were brought to India as gifts and tributes from visiting dignitaries (1590–1600)." Except for the critical first decade of the 20th century, there were always more Indian lions in the wild than in captivity, which applies for the present as well, and today, there are more tigers in captivity the world over than in the wild. But what does all this prove – that the captive animals have been imported? As for the hundreds (if not thousands) of captive cheetahs being prepared for the hunt, this is during the Mughal period and 'not even a handful – encountered in the wild' refers to the British era two centuries later. If the tiger could suffer a 100% decline in one century, cannot the cheetah and the lion suffer a larger decline in four? Besides, if Valmik Thapar admits that there were, indeed, thousands of cheetah in captivity and that they are poor breeders in captivity, were they imported in thousands without a single record of import being found prior to 1918? As for the 'visiting dignitaries' that are purported to have given gifts and tributes of cheetahs to Akbar during 1590 and 1600, it could only have been the Portuguese and Oriental dignitaries, as the East India Company was founded only in 1599 and its representatives and the French came later. Is there a single mention of any imported cheetah given as a gift or tribute mentioned in the chronicles of the meticulous Abul Fazl or in any other contemporary source? Neither history nor natural history can be founded upon surmises based upon wishful thinking.

Before considering the possibility of imported lion and cheetah escaping captivity and establishing sizeable populations over a large range in India, which is the theme of the book, it would be appropriate to consider certain basic issues. If the lion was brought into India first with or before the invasion of Alexander the Great in the 4th century BCE as is purported by the authors of the book, they would have become highly domesticated over the long period of overland travel and entirely dependent on their captors for their food. Could they have survived an existence in the wild after becoming free and able to hunt wild prey on their own? We are all familiar with the difficulties in establishing captive carnivores in the wild and the fatalities that they suffer in the process. The expertise that man has developed in this regard was not known then. Furthermore, even if some escapee lion and cheetah survived recapture and were able to capture wild prey, could they have survived the competition that they would have had to face from the large populations of large carnivores already in occupation of the country's wild lands, and then to have multiplied to the numbers that are recorded in history and to have spread so widely? The only record that exists of imported animals being released in the wild in India, in this case African lions introduced in the early part of the last century by Maharaja Madho Rao Scindia of Gwalior, met with failure. The predicament of the cheetah would have been much worse, as it is a much smaller and a far more timid predator. Besides, cheetahs are notoriously poor breeders in captivity, a fact which is highlighted by Emperor Jahangir himself in his memoirs and is admitted by Valmik Thapar, who circumvents this factor by conjecturing that these cheetah must, therefore, have been imported into India in their hundreds (if not thousands).

The only other record of imports that exist are of a few African lions being imported as exhibits in zoos and there is no record of any of these escaping into the wild. Divyabhanusinh makes a generous estimate that less than 200 cheetahs were imported between 1918 and 1950 by Indian princes for the sport of coursing blackbuck (Divyabhanusinh 2006, p. 155). However, Valmik Thapar ventures that "my research shows that at least 1,200–1,500 cheetahs could have been imported into India in the 20th century." No evidence cited. Our extensive research over three decades has not thrown up a single record of either of the two cats escaping their handlers to go feral and proliferate in the wild.

The first chapter of the book 'The Lion: From Pride to Metaphor' by Professor Thapar is a fine exposition of the lion's position in Indian culture and tradition. She begins with the disarming statement that "I am not a specialist in the history of wildlife in India let alone the lion", and that her "intention is not to prove or disprove India being the natural habitat of the lion or the cheetah, but rather to consider when their presence came to be recorded and how they were perceived." Yet she goes on to question whether the Indian subcontinent was a natural habitat of the lion, in 'contrast with the tiger whose indigenous habitat being India, apart from elsewhere in the East, cannot be questioned.' Any layman naturalist would agree that the lion habitats of southern and eastern Africa are very similar to the present and past habitats of the lion in India. As for the tiger having its 'indigenous habitat' in India, does Professor Thapar claim that the tiger evolved in India, a premise that even Valmik Thapar does not assert? We presume not, and therefore, do not put forth for the present the voluminous and incontrovertible evidence that proves beyond doubt that the tiger evolved in northern and north-eastern Asia and is an entrant into the Indian subcontinent, like the lion and the cheetah.

Professor Thapar mentions the lack of depiction of the lion on Harappan seals and in the rock art of Central India, including Bhimbetka. However, the lion has been depicted in the rock art of Bhimbetka (Badam and Sathe 1992, p. 190). In an exhaustive study of the cave paintings of Bhimbetka, Yashodhar Mathpal has reported three lions from there, the one in shelter C-21 executed in transparent vermilion and two in shelter C-50 painted in opaque colour. One of these three paintings he assigns to the pre-historic period and the other two to the historical period. He also identifies a painting in shelter C-9 as a cheetah in the historical period (Mathpal 1984, pp. 103, 104, 206, 210). Lions are also depicted in cave paintings in the districts of Bhilwada, Bundi, and Tonk in Rajasthan.

Professor Thapar points out further that the lion is conspicuous by its absence, unlike the tiger, on the seals, pottery, etc. found in Harappan cities, including in areas of Gujarat where the Harappans had settled and where lions are still to be found. The Harappan script has defied interpretation. We do not know why depictions of some animals have so far not been found and we have no answer yet as to why a mythical animal, the unicorn, is so commonly shown. We also do not know, for example, why the ubiquitous leopard and gazelle are also absent. Are we, therefore, to conclude that these animals too, did not exist in India at that time, like the lion? After all, the absence of an animal in the pictorial or sculptural record is not proof that it never existed. Such artifacts are about cognition and perception, as much as about real life presence. Professor Thapar also states that lions were imported in recent times in Gujarat where they thrived. There is no record of such imports resulting in feral populations of lions and she gives no evidence of any imports actually having been carried out.

Though the lion is not depicted in the exquisite seals of the Harappan period (*c.* 2600–1700 BCE), it makes its appearance in Indian art in the form of terracotta figurines a little later. A coin dating from 2nd century BCE recovered from Taxila, Pakistan, also illustrates a lion (Gorakshkar 1979, p. 12). They are also carved in terracotta bricks and figurines of the 5th century CE, found both in Sindh, Pakistan and in Mathura of the Gupta period (Gorakshkar 1979, pp. 7–11). It is indeed significant that when the great warrior king Samudra Gupta (c. 335–376 CE) conquered the Gangetic valley, the abode of the tiger, he issued his tiger-slayer coins and when his successor Chandra Gupta II (c. 376–415 CE) conquered Malwa and Saurashtra where the lion lived, he commemorated his victory by striking his lion-slayer coins (Iyer 1977, p. 63). Are we to presume that all these lions were the progeny of lions imported in ancient India?

It is contended that the lion makes its appearance in ancient art forms only with the Mauryan pillars. This is only partly true, as discussed above. Besides, prior to the Maurya-Satvahana period the medium of artistic expression was wood, which has not survived. Sculptures on stone appear during this period and it would be incorrect to say that the lion is only confined to Mauryan sculptures. The animal is commonly depicted on the gateways of the stupas of Bharhut and Sanchi. Indeed, the lion occurs far more frequently than the tiger in ancient Indian plastic art, but that is not a proof that there were no tigers or that they were far fewer than the lion. Rather, the lion with its mane showed more impressively than the tiger in such art forms.

Professor Thapar and her co-authors have largely based their theory of the lion and the cheetah being aliens and ‘imported impostors’ on the grounds of lack of their depiction in art and of mention in literature. When the lion does appear in sculpture and otherwise, it is labeled as stylized and unnatural and possibly adopted from Achaemenid Iran and Assyria. Professor Thapar does say that the Rig Veda, the earliest Aryan (Vedic) text dating from their first settlements in the land of the five rivers (Punjab) in India, prior to the last millennia BCE, mentions the lion but not the tiger, which is first referred to in the subsequent Vedas when the Aryans moved eastwards into the valley of the Ganga and the abode of the tiger. But significantly, the lion is also mentioned in these later Vedas, together with the tiger. Professor Thapar tries to explain the mention of the lion in the Rig Veda, perhaps because it would be ridiculous to claim that the Rig Vedic lions could be imported escapees, by suggesting that the lion could have been a memory of the Aryans from their Iranian past, while they were settled in the Punjab when the Rig Veda was written. And she postulates that the memory of the Iranian lion perhaps still persisted with the Aryans when they moved into the lower Ganga valley, millennia later! She goes on to mention that the historian Arrian, writing in the 2nd century CE but describing Alexander’s campaign in India in the 4th century BCE, does not mention a lion hunt, but Alexander is mentioned hunting lions in the trans Oxus area of Balkh. She presumes, therefore, that lions could have been imported from Balkh and Bactria, which were in close contact with north-western India. How? Were they captured and brought over high passes of the Wakhan Pamirs, the Himalaya and the Hindu Kush, and released/escaped in India? Were these the lions which were the progenitors of the lions which Professor Thapar mentions are cited in the chronicles of Pliny and Aelian writing in the early years of the Christian era? Professor Thapar does not venture to clarify. Where did these lions found in Balkh and northern Afghanistan originally come from? Obviously from Iran, Turkmenistan, and Afghanistan. Could not lions from the same Iranian population cross into India through Baluchistan on their own, this being far nearer and easier than the arduous trek that the lions themselves admittedly undertook to reach Balkh from Iran? Do lions have to be captured and carried over some of the most rugged and high terrain in the world, in the 4th century BCE, under some ostensible lion introduction programme, to be found in India?

As for the cheetah, Professor Thapar rightly points out that references to it are rare. She refers to the work of Erwin Neumayer on prehistoric rock art in India and says that it does not depict this animal, nor the lion. She however, omits mention of what was a pioneering and seminal work on rock art by V.S. Wakankar and R.R.R. Brooks, which clearly shows a Neolithic/Chalcolithic (2500–2300 BCE) painting at Kharvai, east of Bhopal in Raisen district, Madhya Pradesh, identified by the authors as that of the cheetah (Wakankar and Brooks 1976, p. 45). Though the painting (Fig. 1) is somewhat stylized and the depth of the body is enhanced to show the large spotted cartouche within it, it is obviously that of a cheetah and not of a leopard, which has been depicted in other rock shelters in the Satpura National Park and elsewhere in the neighbourhood, showing the head, heavy thighs, and other features characteristic of the leopard (Fig. 2). In the Kharvai painting, the thin, hound-like legs, the small bullet-shaped drooping head with a short neck, the tell-tale arched withers, and the concave spine whose elasticity gives the cheetah its speed, are unmistakable. In the Karad (Karabad) rock shelter west of Bhopal, a small and a large cheetah trailing it (a cub and its mother?) are painted in a style almost identical with the Kharvai cheetah and belong to the same Chalcolithic/Neolithic period of c. 2500–2300 BCE (Fig. 3). A spotted felid greatly resembling a cheetah, about to be shot by a hunter with a bow and arrow, has been found in the rock shelter at Chaturbhujnath in the Chambal valley. There is another slightly crude painting but clearly that of a cheetah, in the nearby rock shelter at Silajit, also in Raisen district. Incidentally, paintings of leopard and tiger in these profusely illustrated numerous rock shelters of this region, are relatively rare. But that does not imply that these two carnivores were rare in these forests, which even today hold some of the highest populations of the tiger and of the leopard in India.

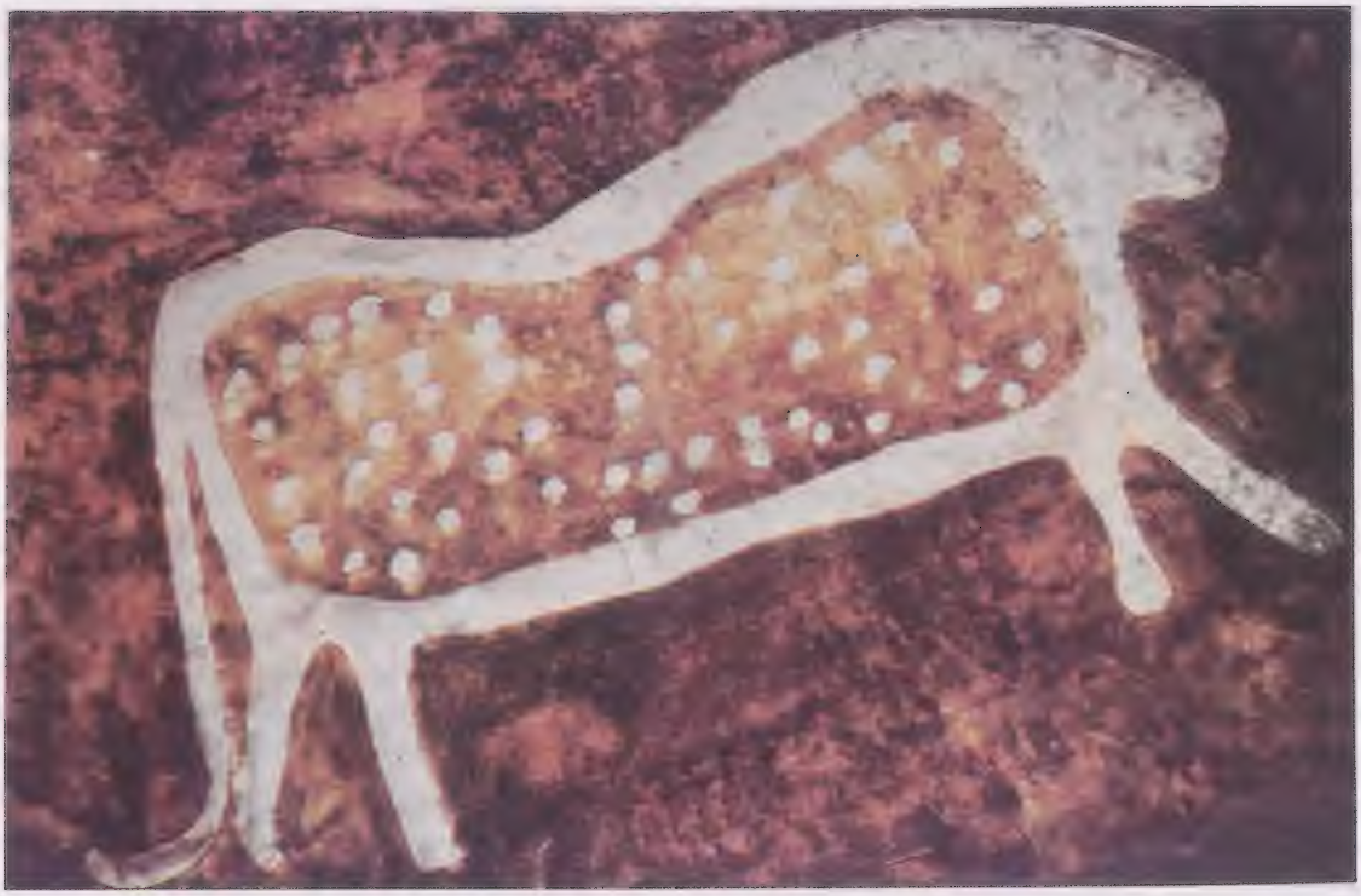

Fig. 1: Cheetah painting from rock shelter at Kharvai, Raisen district, Madhya Pradesh. Chalcolithic/Neolithic period, *c.* 2500–2300 BCE. The characteristic small drooping head, short neck, arched withers, concave spine, and thin, hound-like legs are unmistakable

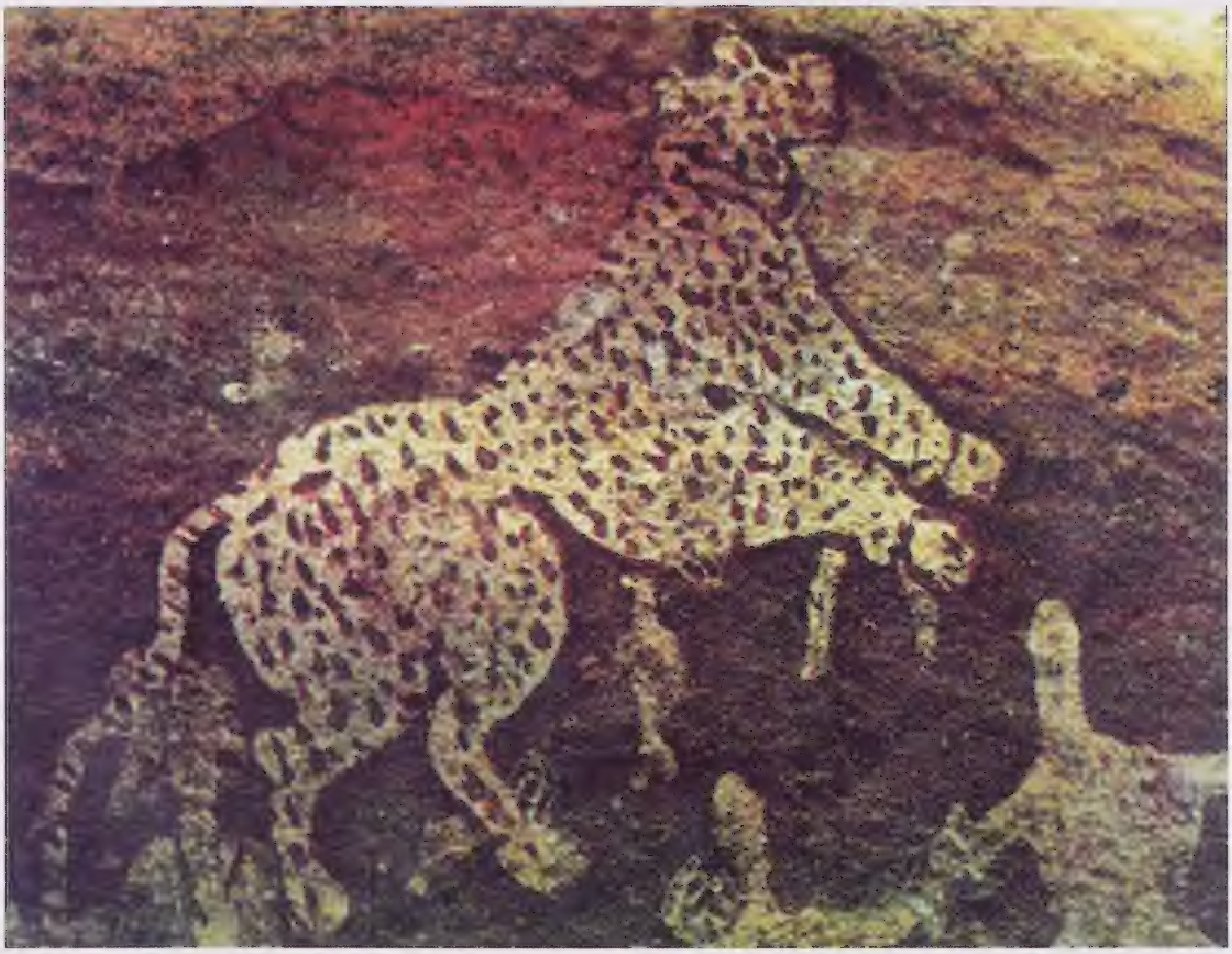

Fig. 2: Leopard painting from rock shelter at Baghbani, Raisen district, Madhya Pradesh. Chalcolithic/Neolithic period, *c.* 2500–2300 BCE. Note the difference in physical configuration compared to the Cheetah above, especially the heavier limbs and head shape

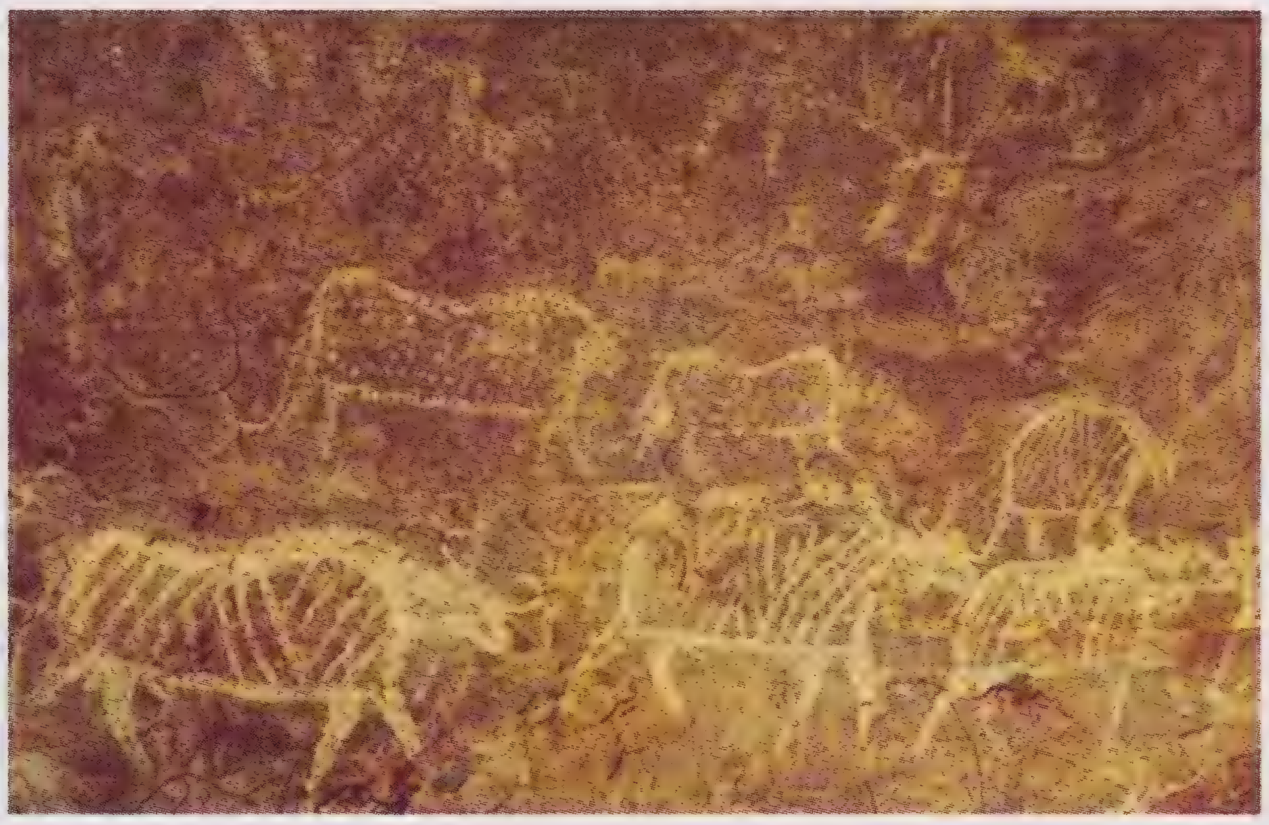

Fig. 3: A pair of Cheetah, perhaps mother and cub; Chalcolithic/Neolithic period, *c.* 2500–2300 BCE. Karad (Karabad) rock shelters near Bhopal, Madhya Pradesh

Equally significant are the archaeological bones of the cheetah of the Mature Harappan Period (*c.* 3000–2500 BCE), discovered at Kanmer, Gujarat (Goyal and Joglekar 2012) and again at Raja Nal ka Tila, Uttar Pradesh, dated 700–200 BCE (Joglekar, unpubl.). Are we to assume that cheetahs were imported into India in the Harappan era?

Professor Thapar examines the *Manasollasa* which is a 12th century compilation by Someshwara III, the Chalukya king of western Deccan, which describes various methods of hunting deer, one of them being *vyaghraja*. The description here is that of a *chitraka,* a cheetah, also referred to as *vyala vyaghra,* trained to hunt *krishnasara* (blackbuck) or *harina* or *mriga*. Though there is multiplicity of names for both the hunter and the hunted, the description of the process leaves no doubt as to the identity of both (Divyabhanusinh 2006, p. 27). She points out that the Chalukyas could well have learnt this art from Arab contacts on the western coast. Once again what evidence do we have of this?

Professor Thapar goes on to add "Unfortunately, the texts that speak of trade between various parts of India and places to the west and the north do not mention the coming and going of large animals… However, animals such as the one-horned rhinoceros and tiger, together with peacock and parrot, are mentioned as common to the Deccan. These animals find their way to the Mediterranean… If such large animals could be transported, then so could the lion. But there are *no references* to lions, neither coming to India nor being sent out of India in these times." The emphasis (italics) above is added, but is a clear admission of the absence of evidence for the core thesis of the book.

Yusuf Ansari states at the beginning of the chapter 'Animals of the Chase' that Persian, Greek, and Assyrian accounts suggest that lions were exported or found their way through trade into new ranges and this could be how the Asiatic lion came to India. He does not cite the authorities on which this statement is based and goes on to state that this holds more water than theories of Indus drying up and allowing the lions to come from Persia. Lion dispersal through Asia as a natural process is part of a much larger process of mammalian migration over millennia. If this dictum has to be challenged it cannot be done by propounding a theory without any evidence to support it.

Yusuf Ansari, like his co-authors, expostulates that as the lion was kept in game parks and hunting reserves throughout its former range "Where the animal was enclosed, bred and stocked to be hunted and as material for diplomatic tribute and spectacle... This could be how the Asiatic lion (*Panthera leo persica*) arrived in India". Again this is an assumption. Yusuf Ansari is a historian like Professor Thapar. Yet neither cite concrete proof nor sources for their surmises. In his second chapter in the book, Ansari states that "The few instances in the *Akbarnama* which describe Akbar's personal capture of cheetahs occurred in or near imperial hunting grounds, suggesting that the "captured" cheetahs were either escapees or feral animals." Firstly, hunting reserves and game parks which are repeatedly mentioned by all three authors, were reserves of the Mughals or other Indian royalty which were strictly protected for hunting by the kings and their family and guests. They were not stockades into which exotic animals were introduced. If there was an encirclement of these reserves, it was a temporary one with nets or barriers to facilitate hunting for a given period, during the Mughal period. If there was any captive breeding, it was only of lions, it occurred only in cages, and there is no record and none cited by the authors that lions were bred in large, stockaded game reserves, or that any captive-bred lion was ever released into any game park or reserve. Even assuming the surmise of the authors that the lions were bred in captivity, where did the parent stocks come from – imported and for which there is no record? And for the cheetah which admittedly could not be bred in captivity, where were they imported from in thousands? The Asiatic cheetah is closer genetically to the North African counterpart, as mentioned earlier. By the time of the Mughals, there were few cheetahs left in North Africa and the trade, such as it was, was with eastern Africa, from where the celebrated Burchell's zebra was imported to the court of Jahangir. The Asiatic lion too is similar to the North African animal, as discussed earlier. Is it claimed that the Indian lion and the Indian cheetah in thousands were imported from northern Africa? Were there any organized capture undertakings prevalent in this region to enable such a mass capture and translocation programme and transport over the Indian Ocean thereafter? Is it purported that the lion and the cheetah were captured in the Maghreb area of North Africa, transported over land to Egypt and then shipped out through the Red Sea? A theory must have some proof and practicality.

Ansari quotes Nizami that Qutb-ud-din Mubarak (1316–1320) had two to three thousand deer-hunting panthers. This he claims to be an exaggeration by Nizami to glorify the king and his reign. But such an exaggeration would surely be based on large royal menageries of cheetahs. Nizami's description is complemented by Shams Siraj Afif's description of Firoz Shah Tugluq's menageries, which had so many cheetahs that one could not count them. Is this too intended to flatter the king? The statement could not have been made if the royal court did not have a large number of these animals for the chase in the first instance. Ansari goes on to assert that the acquisition of lions appears to "astonish even the court chronicler… In any case, the narrative undermines the notion that lions commonly ranged all over north India in the fourteenth century, and states the actual rarity of the animal." Let us examine Afif's other statement, which Ansari surprisingly does not quote: "Indeed, during his reign, by the inspiration of the Lord God, Sultan Firoz Shah acquired a number of lions (*shir*). And *baz, turumti, bahri, shahin, simtans* and the like there came to be so many that it cannot be brought within the grasp of human comprehension or imagination." (Hussain 1891, pp. 326–327; Divyabhanusinh 2006, p. 22). Clearly, the invocation of God and/or astonishment is with reference to the entire menagerie, rather than to the lions alone. Where did these lions and cheetahs come from? Were they imported?

Ansari quotes A.L. Basham that the practice of hunting with cheetahs may have been learnt from the Muslims. This is no more than a suggestion and is in line with Professor Thapar's statement in the earlier chapter. One must then ask as to how the Indians were taming *pardalis* and *panthera* 2000 years ago, as noted by Strabo the geographer and Aelian the chronicler of animals?

As to the parks for hunting which Firoz Shah maintained like many of his predecessors and successor, he reserved areas including 'wastelands' for hunting, which he improved by supplying water to increase the prey species. But where is the evidence of the lion's and the cheetah's imports and release into these hunting reserves?

In his chapter 'Shahanshah's Shikar', Ansari points out that Babar does not give any details of the lion or cheetah in his memoirs (Beveridge 1979, pp. 488–92). This is correct. But does Babar mention the lion in Afghanistan, where the authors of the book themselves admit the presence of lion and where Babar spent far more time than his four years in India? If not, would the absence of the mention of the lion in Babar's memoirs prove that the lion did not exist either in India or in Afghanistan?

Abul Fazl's description of cheetahs and their management in his *Ain-i Akbari,* is a part of the description of the Empire and its administration. This work clearly mentions the large numbers of cheetahs at court. Abul Fazl does not mention the import of any lion or cheetah.

Ansari points out that the record of 1,000 cheetahs of Emperor Akbar has always been doubted and needs 'conclusive burial'. Jahangir writes in his autobiography that during his reign in 1613, a cheetah from his menagerie mated with a female of its own accord and two and a half months later three cubs were born and grew up. "This has been recorded because it is strange". The point he was making was that though his father Akbar had 1000 captive cheetahs at one time and he tried mating them, reproduction did not happen (Rogers and Beveridge 1978, p. 240). Jahangir was recording a very unusual event and it was in this context that he records that his father had 1,000 cheetahs. It was, therefore, not a statement boasting of his father's vast collection of cheetahs and must, therefore, be taken at face value.

Ansari cites Raghu Chundawat, who gives an estimation of the number of blackbuck required to sustain 1,000 and 9,000 cheetahs – the latter being the figure Akbar collected in his reign of half a century.

It is worth noting that around 1600 CE, not more than one fourth of the land mass was under permanent cultivation and the density of the population at 35 to a square kilometre, was half that of 1881 (Guha 2001, p. 60). In the late 19th century, Rangarajan shows that the number of tigers killed each year was 1600, leopards 2000 (Rangarajan 2001b, p. 32). We are today reluctant to accept the incredible numbers of ungulates and their predators that once roamed this country. The authors of this paper were privileged to have witnessed in their youth numbers which would appear fictitious to most, and yet this was at the very end of the era of plenty. The earlier hunting records of the princes and of the British speak of much larger numbers and the hunting records of the Mughals mention *Qamargah*s in which thousands of animals were encircled and slaughtered. There is a mention of one such *Qamargah* in 1567 near Lahore in which over 15,000 animals were killed (Ranjitsinh 1989, p. 2). So why should we doubt the numbers of prey and predator species that are quoted to us in medieval records?

Ansari quotes an instance of Raja Bir Singh Deo of Orchha shooting one of Akbar's cheetahs which had escaped from captivity. However, the Raja was soon caught by the people who were looking for the cheetah. This is not indicative of cheetahs escaping in large numbers to found a wild population. The point is: it took a strict, long, and painstaking regimen to train a cheetah to hunt for man. It was an expensive proposition. An escaped animal would be immediately followed and brought back, as was the attempt in the instant case. While there is no evidence of cheetahs being imported during this time, an imported animal would have been even more costly – too costly to let it roam free!

Mirat-i Ahmadi of Ali Muhammad Khan, a treatise on administration during Aurangzeb's time, states that cheetahs found in north Gujarat 'were better and superior' in relation to those from elsewhere and, therefore, the empire maintained a special department in Gujarat 'to catch, train and tame them'. The treatise goes on to describe the organization of the department in detail. Among several others there were 20 cheetah catchers in this department who were paid Rs. 80 each (Ali 1930, p. 187). Jean de Thevenot visited Ahmedabad about this time and he records that the governor of the Suba does not allow anyone else to catch cheetahs from jungles surrounding Ahmedabad (Sen 1949, p. 16).

Muhib Ali Khan Khass Mohalli, Akbar's governor of the Delhi Suba wrote a remarkable *Baznama* in which there is a chapter on cheetahs. He writes: "It should be understood that just as colour of hawks varies, so the colour of the cheetah varies too. There are desert (*rigi*) cheetahs and mountain cheetahs. Mountain cheetahs are ash grey (*ramadi?*) and some of them red too. A true desert cheetah which has not… is not very red in colour. (They are?) powerful and strongly built... The mountain cheetah favours the shade and runs little. It favours the shade because it always hunts in the shade. It runs little because in the midst of the mountain jungle it takes the gazelle unawares and catches it easily. But the desert cheetah is not lazy when it is hot, but runs well. It knows running well" (Mohalli). If Akbar's cheetahs had indeed been imported, such differentiation would never have been there.

There is a manuscript of the incomplete *Baznama* from Tonk, Rajasthan, which is a 19th century copy of an earlier document according to Professor Muzaffar Alam (*pers. comm*, 1994). According to this source, the cheetah is 'found everywhere and specially at five places: Multan (Punjab), Lakhi Jungle (Sindh), Ajmer (Rajasthan), Gujarat, and Deccan. The *Yuz* found in Multan and the forest of Lakhi is short and swift, those found in Gujarat, are tall in height, while they are of medium height in the Deccan.' (Anon. undated)

James Forbes, the British traveller and chronicler of the early 19th century, also records that the cheetahs of 'Gujarat are the most esteemed' though they are found all over India (Forbes 1813, Vol. I, pp. 272–77).

Ansari refers to the Mughal scholar Annemarie Schimmel, who makes an 'intriguing assertion that cheetahs had become thoroughly "acclimatized", especially in Gujarat', which could well imply their getting accustomed to captivity while being trained, Gujarat being a well established source of capture and training of cheetah. What Ansari does not quote, from the same passage, is that the cheetahs 'were caught in the jungle, usually in pits, and then transported blindfolded, in wicker covered carts to the stable for training' (Schimmel 2005, p. 220). Is this another instance of selective referencing where only convenient passages are quoted from a source?

The eminent historian Irfan Habib has meticulously examined Mughal period records and has identified several areas from where cheetahs were caught for the imperial court. They were the environs of Pattan, Bhatnair, Bhatinda, and Hissar in the Punjab and Haryana; Jodhpur, Nagaur, Merta, Jhunjhunu, Amarsar, and Dholpur in Rajasthan; Jamnagar and Sidhpur in Gujarat; and Alapur and Gwalior in Central India (Habib 1986 sheets 4B, 6B, 7B, and 8B). If cheetahs were indeed imported in huge numbers as alleged by the authors, where was the need to resort to such extensive and expert capture operations?

The only conclusion one can draw from the foregoing is that cheetahs were in India for thousands of years to have been found all over the Mughal Empire and to have acquired sufficiently noticeable morphological and behavioural differences, to enable the Mughals to identify them from different regions and select the best for coursing blackbuck.

It is pertinent to record that the cheetahs had become a nuisance to humans, like the lion, tiger, leopard, wolf, and others, even as late as the British period. They too carried a bounty on their heads and between 1872 and 1903, bounty hunters accounted for 77 cheetah from various parts of India (Rangarajan 1998).

Valmik Thapar has authored all the subsequent chapters. In the chapter 'In the Court of the Emperors', he asserts that the behaviour of Gir lions resembled large dogs. He describes the calls of the forest department staff which attract them. He neglects to note that owing to a large cattle population of the Gir, lions prey on them, and they account for a substantial part of their diet. Maldharis' calls to their cattle naturally attract lions, which the wildlife guards mimic. The behaviour of lions in the Gir away from Sasan is not so tolerant of humans. We remember photographing wary lions at dusk from hides in the 1950s and early 1960s. Lion behaviour has changed, as that of the tigers in Ranthambhore, and elsewhere. Protection, and constant, close contact with humans have made tigers diurnal and we and Valmik Thapar as well have spent hours with tigers sitting (dog-like) in water and out of it. The lions of the Gir are very tolerant of human presence for various reasons. However, a recent study by a field zoologist and a well-known lion expert who has studied human-lion conflict for years, has found that lions attacked humans 21.8 times (annual average) between 2000 and 2005 each year, and these attacks increased to 30.25 annually between 2006 and 2010. In the latter period, there were 13 attacks (annual average) in the Gir West (Venkatraman 2012), which is the tourist epicentre. Lion behaviour has undergone changes in times. There are also the well-known works of Saberwal *et al.* (1994) of the late 1980s and early 1990s period and Rangarajan (2001a) for the 1899–1901 epoch, the latter referred to by contemporaries as a time of a "reign of terror" by lions that hunted humans. To refer to these large cats as mongrels, or dogs of mixed pedigree, is indicative of a prejudice and bias and does not behove any nature lover.

Valmik Thapar argues that since the nilgai was not the lion's natural prey, India did not have 'the millions of blackbuck that would have been needed for the "indigenous" lions and cheetahs to feed on'. Firstly, India did have millions of blackbuck, at least in the Mughal times. The eminent scientist, C.P. Groves, estimated that the Indian subcontinent had as many as four million blackbuck (Ranjitsinh 1989, p. 44). T.C. Jerdon speaks of 10,000 blackbuck at a government cattle farm at Hissar, Haryana (Jerdon 1874, p. 277) where Ranjitsinh has also seen a thousand in 1956. Jahangir records that in a 12 day hunt with cheetahs 'within the limits of Palam' where Delhi's airport is now situated, 426 antelope were caught (Rogers and Beveridge 1978, p. 109). Ranjitsinh who has done his doctorate on the blackbuck, has reason to believe that the Saurashtra Peninsula alone had over 80,000 blackbuck as late as 1947 (Ranjitsinh 1989, p. 44) and Rajasthan had even more. He has seen over 3000 in one morning and records over 1000 in the Bhal area, where the Velavadar National Park in Gujarat is situated (Ranjitsinh 1997, p. 169). Secondly, cheetahs did not live on blackbuck alone but also preyed on gazelle, pig, young nilgai, primates, hare, peafowl, cheetal, and four-horned antelope which were far more widespread than they are today. The blackbuck was no prey of the lion, and it is absurd to say that they were dependent on this antelope and the nilgai. Wild pig, sambar, and cheetal were also their prey then as they are now. Valmik Thapar mentions that there are very few records of encounters with prides of lion in India, whilst in Africa a pride of lions can have as many as 30 beasts. Apparently, the author is not very familiar with the Indian lion. We have seen a pride of 26 members and several with over 10.

Valmik Thapar asserts that "it is inconceivable that lions could have swum across the Indus (unlike tigers, they hate water)." Recent radio telemetry on Gir lions has revealed that lions often swim across large stretches of water. A pride of eight lions was recorded swimming across a 2 km stretch of deep water on several occasions and this pride was observed to make use of deep water to make a kill by driving the prey into the water and killing it there. Thus, the proposition that Indus would have been a formidable barrier for lions to cross and that it needed to dry up for lions to cross it naturally, is not an acceptable theory (Jhala pers. comm. 2013) Anyone who has watched the *National Geographic* documentary 'Swamp Lions' of the Okavango in Africa, where lions live almost an amphibious existence for a part of the year, would not believe that lions 'hate' water. Valmik Thapar cites that there is no proof of the occurrence of lions in Afghanistan and Baluchistan, and hence, how could they have migrated into India. But the lion need not and perhaps did not cross into India over the Hindu Kush from Afghanistan, as the more obvious route would have been from Iran through southern Baluchistan and the Mekran coast. This inhospitable and arid tract is not conducive to the preservation of any evidence and has no record of the passage of any animal movement of the past, including that of the ostrich and others. The Sinai Peninsula also does not record the passage of the lion and others, but that does not imply that the Sinai and the Mekran coast/southern Baluchistan were not land bridges of animal migrations. It would be pertinent to mention that cheetahs which must have also used the Mekran-Baluchistan passage into India, were reported in that area till as late as 1997 (Divyabhanusinh 2006, pp. 194–197). Thapar goes on to say that lions were trafficked, especially to Rome from about the 3rd century BCE to about the 5th century CE. This export was from the Barbary coast of North Africa, which was already a part of the Roman Empire and ships regularly plied the Mediterranean. Bringing the lions to India from the North African coast would have meant a trans-shipment to the Red Sea, as there was no Suez Canal then. Is there any report of this anywhere?

Valmik Thapar then goes on to say that in the 20th century when the Indian lion had almost become extinct, "The Nawab of Junagarh decided to manage the population in Gir (his then designated hunting ground) through intensive artificial feeding and protection. Did the Mughal emperors do the same in their time? Was the "Royal Lion House" a breeding and holding station to train lions for the court and release them into the stage-managed hunting grounds of the emperors?" The Nawabs of Junagarh fed lions in only the Sasan area of Gir and that too only when they had to shoot or show lions to their guests. Valmik Thapar, however, conclusively claims "Whatever might be the truth about Ashoka's lion pillar, one fact is certain… the lion in it did not come from lions in the natural landscape of India but from connections across the seas." Again he asserts "Whichever way you look at it, exotic animals were brought in from across the seas, be it from Mombassa, Zanzibar or Mozambique and all of them were dropped off on the western coast," and "as far as I am concerned cheetah in India came into the country as gifts or tributes and were imported by land and sea from Africa and Persia". The absence of proof and the dogmatic assertions continue.

Valmik Thapar quotes Guggisburg to assert that there were no lions in Afghanistan. This is contrary to Professor Thapar's assertion that this was the Rig Vedic land and it held lions. Joslin reports that there were lion reports from Afghanistan till 1888, from Sindh up to 1847 and from Iran up to 1942 (Joslin 1973). Baluchistan was a difficult place then as it continues to be today, and no one has recorded lions there in the 19th and 20th centuries, apart from one probable instance from Las Bela in 1920. Further, Valmik Thapar comments that the Nawab of Junagadh decided to 'manage' the lion population. What does he mean? They protected them certainly, but there is no record of breeding them for releasing them in the wild. He goes on to state that because of royal privilege, anything to do with lions "was always kept secret and that is one of the reasons why there are so many missing links in our understanding of this species". This is not a responsible claim or statement and such conjectural assertions cannot be accepted as fact.

Again we have Guggisburg being quoted: He 'thinks' Indian princes may occasionally have trained lions for the chase. No authority has been cited either by Guggisburg or by Valmik Thapar. The latter writes "while others have described lions at Jahangir's court, it is odd that the emperor's own memoir do not mention a single lion... the reason Jahangir does not dwell on lions or lion hunts is because the animal was so rare…". If anyone reads the *Tuzuk-i-Jahangiri*, he will be impressed at Jahangir's description of his lion hunts. He records shooting of two lions which were making a nuisance of themselves between Panipat and Karnal in 1608; the Anup Rai incident of 1610; demonstrating his skill to Prince Karan of Mewar at Ajmer in 1615; the famous Noor Jahan's shikar of 1617 near Mandu, when she shot four lions, when he gave her a fabulous gift, and there are other such instances. In fact, two of these incidents have been immortalized in two remarkable paintings. Jahangir goes on to record that in a span of 39 years he had shot 86 lions. In 1610, he records having shot seven lions near Rupbas in a hunt of 56 days, when he also shot 70 nilgai, 51 blackbuck, and 82 other animals (Thackston 1999, pp. 108, 216). Valmik Thapar quotes Tavernier to illustrate how lions were tamed and made safe for display at court. But where did the lions come from?

Valmik Thapar mentions that the inveterate Arab traveller Ibn Batuta, who traversed India between 1324 and 1354, never mentions the lion. But does he mention the tiger and if he does not mention either the tiger or the lion, are we to presume that neither existed in India in his time? Valmik Thapar states that Jahangir does not mention the lion, because this animal was so rare. But then what happened to the numerous lions which Valmik Thapar and his co-authors claim were in royal menageries and were regularly released in royal hunting reserves? More of this later.

Both the translators, Rogers and Beveridge, of the *Tuzuk-i-Jahangiri* and others including Valmik Thapar have been misled by the confusion over the words *Shir* and *Babr*. The Persian word *shir* means a lion, whereas the word *babr* means a tiger (Humphrys and Kahrom 1995, pp. 75, 77; Firouz, 2005, pp. 65, 66). In popular Hindi or Urdu parlance, just the opposite is the case. Emperor Jahangir wrote his memoirs in Persian and in his own hand. He knew what he was observing and writing. The confusion is ours. Mughal miniature paintings are full of lions. The tiger on the other hand is prominent by its near total absence during the reign of the Great Mughals.

Valmik Thapar repeatedly mentions the flourishing trade in exotic animals, especially lions. But quotes no record of any imports of lion and cheetah in India in the medieval period, nor during the existence of the East India Company. Neither of us, both being students of history, have ever come across any such record either. As the entire thesis that the lion and the cheetah are exotic imports in India is based upon the paucity of mention in ancient records and of portrayal in prehistoric art, should not the total absence of mention of this purported import in medieval and modern records also indicate that such imports never occurred?

Valmik Thapar quotes F.G. Careri, who mentions countless tigers near Diu on the coast of Saurashtra, to claim how domesticated and 'dog-like' the captive lions were in India and therefore "appear to have been bred in hunting grounds as they seem tame enough to be jumped on and beaten to death." The relevant quote from Careri states that when the African slaves of the Portuguese saw a lion astray in the woods, one slave would distract the lion while the next Black (slave) "very dexterously takes the Beast by the Testicles and then they beat him to death". Does Valmik Thapar really believe that even a most decrepit tame lion, let alone a wild one, would allow anyone to catch it by its testicles and then to beat it to death?

Careri also describes a lion hunt which he confesses he had not seen, but "was generally told to me by the Portuguese: The Reader may believe what he pleases". On this basis Valmik Thapar chooses to believe and conclude that the lions appear to have been bred in hunting grounds "as they seem tame enough to be jumped on or beaten to death".

Valmik Thapar goes on to rely on the same Francis

Gemeldi Careri, who records a lion brought to Goa from Mozambique, which was being sent to the king of China. Careri asserts that there were very few lions on the coast of Gujarat or Goa. But, there were never any lions near Goa in recent times. Its coastline indeed held tigers as indeed did the coast of present day Gujarat near Daman. But at Diu, which is close to Gir, Careri claims he saw tigers. Are we expected to give credence to this? The Saurashtra Peninsula has never had tigers. The occurrence of tigers in Daman on the south coast of Gujarat does not imply that lions should also have been there as the lion habitat in Saurashtra is not far away, as Valmik Thapar claims. A look at an atlas would show that a wide stretch of the Gulf of Cambay lies between Daman and the Saurashtra coast. Valmik Thapar goes on to say that there were Dutch, British, and Portuguese vessels, and the Mughal fleet which carried lions and cheetahs along with zebras and giraffes. He, however, as usual does not give the source of his information.

Valmik Thapar quotes R.G. Burton to show that 19 lions were shot between 1847 and 1872 in Gwalior and Guna, the territories of the Scindia rulers of Gwalior, which boasted not only large menageries 'but also restocked their forests with African lions'. But African lions were only imported in Gwalior in the 20th century and there is no record whatsoever of any captive lions having been released by Gwalior in the 19th century. So, where did the 19 lions shot between 1847 and 1872 come from? The portrayal of lions in the Kotah School of Art is explained by "There were probably large animal menageries in Kotah, and Bundi, and it is likely that lions were released into the forests of that kingdom as a result of the numerous battles between the British and Indian rulers at the time." But there were no battles between the rulers of Kotah, Bundi, and neighbouring princes with the British. If there is no evidence of existence of lion or cheetah, it is presumed that they never existed. If they are in evidence, then it is presumed that that was 'probably' because of breeding in menageries! There could possibly never have been non-feral non-escapee lions and cheetahs in India, is the gist of the argument. To support the repeated contention that lions were in stockades and bred in captivity, Valmik Thapar mentions in the caption below the illustration of a lion hunt in Kotah, opposite p. 11 of the book, a 'thick wooden fence in the foreground and background'. A cursory look would show that these so-called wooden fences are in fact lines of trees painted in a stylized fashion. Is this an attempt to deliberately mislead the gullible?

Valmik Thapar again avers that the lion 'had always been rare, which in turn can only mean it was never an indigenous species that had established itself in this country.' How much time does a species require to be regarded as

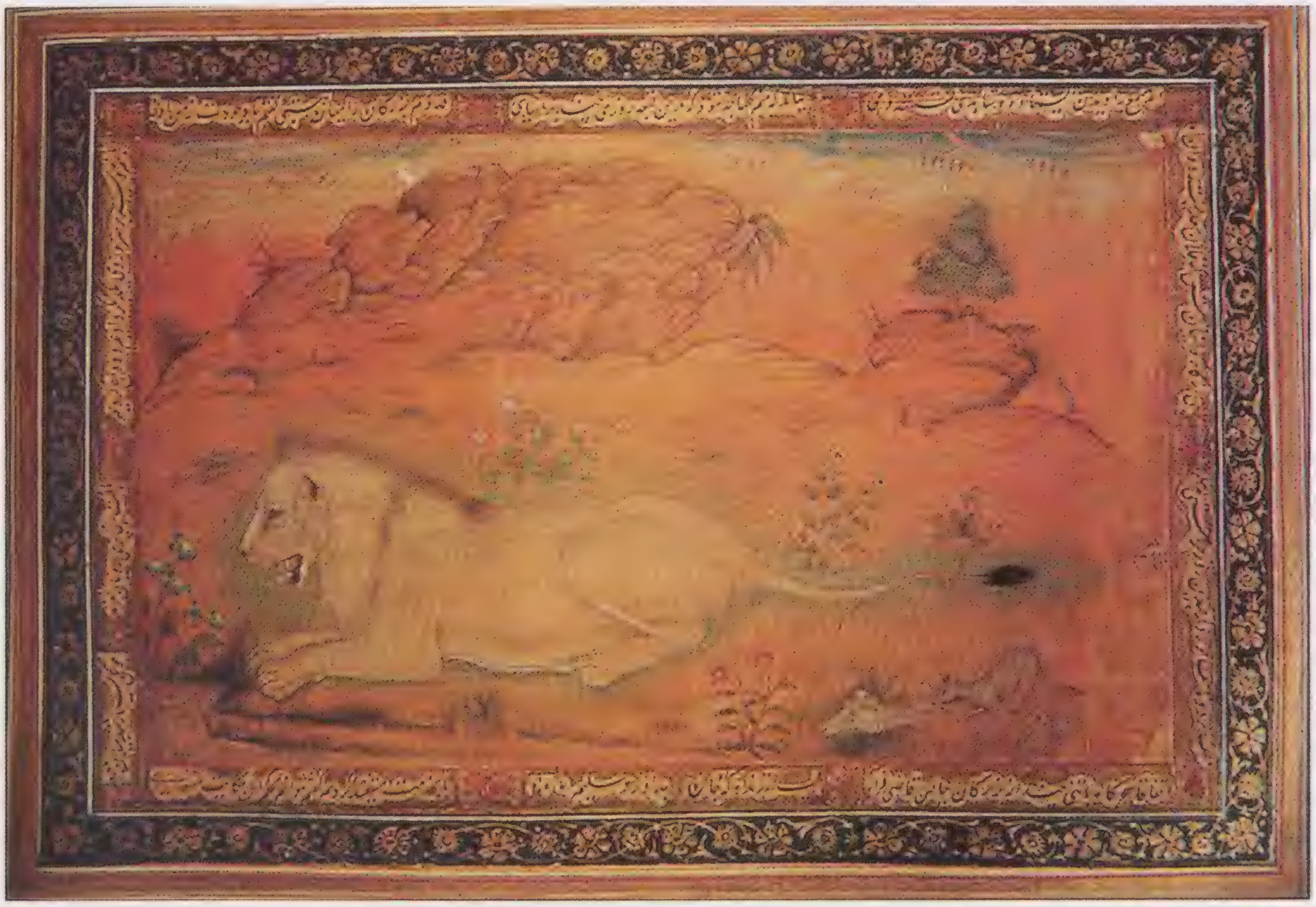

Fig. 4: "Lion at a water hole." Attributed to Emperor Jahangir's painter Nanha, *c.* 1618 (courtesy Maharaja Sawai Mansingh II Museum, Jaipur). The young lion's moderate mane growth over its head exposes its ears and it has a prominent black tassel on its tail.These are noticeable morphological characteristics of the Asiatic subspecies

established in the country or indigenous? Certain species such as the caracal, which possibly also came from Africa like the lion and the cheetah, were always rare and had very restricted distribution in the country. But that does not make them non-indigenous.

Valmik Thapar goes on to say that the last decades of the 19th century were "a time when there were endless rumours that African lions were being brought on dhows from Africa to facilitate hunting, especially by princes who took it as a rite of passage." Can he quote the source of the rumours? Is the belief that Indian lions were imported from Africa even as late as the end of the 19th century, be based on mere rumours?

Then, there are statements by Valmik Thapar which are untrue. He claims that Maharaja Ganga Singh of Bikaner shot 3,300 sandgrouse in one shoot in 1925. This was the bag of the entire hunting party and not of one individual. No single person has ever shot on record 3000 birds in a single shoot. Thapar goes on to say that palaces like the one in Dungarpur in Rajasthan "had wall paintings that depicted numerous African animals, mostly boasting their presence in their private forests". Being closely related to the erstwhile ruler of Dungarpur and having therefore lived in the Palace there, Ranjitsinh can firmly assert that there are no such paintings in the Palace in Dungarpur. Further, Valmik Thapar, quoting from Kailash Sankhala and V.D. Sharma, says that "Among the princely states of Saurashtra (now Gujarat) Bhavnagar and Wankaner were equally famous for organizing the hunting of blackbucks by using cheetahs. Bhavnagar had its agent in Mombassa, Kenya, who regularly supplied the menageries with African cheetahs. The same is true of Wankaner." Valmik Thapar goes on to add that the Kutch and Jamnagar princely states also "Had royal menageries overflowing with cheetahs". The State of Bhavnagar did have cheetah imported from Africa in the first half of the 20th century. However, since one of the authors of this paper belongs to the erstwhile princely family of Wankaner and the other is closely related to it, we can positively affirm that the State of Wankaner never possessed cheetah for purposes of blackbuck hunting or otherwise, and never imported any cheetah from anywhere. They can also affirm that neither Kutch nor Jamnagar kept any captive cheetahs for coursing at any time, and the statement of Valmik Thapar in this regard is also false.

Valmik Thapar says he has examined several paintings and it struck him "that the painters were unfamiliar with the animal depicting it in all manner of strange shapes and sizes..." However, he himself has reproduced accurate renderings such as on pages 121 and 122 and there are scores more, such as Mansur's in the *St Petersburg Muraqqa* (album); a painting which came in the public domain recently titled 'Landscape with Lions and Figures'. There is a lioness in it sitting by the remnants of a human skeleton while a male lion is killing a nilgai; one entitled "Jahangir showing his hunting skill"; "Lion at a water hole" (Fig. 4; Divyabhanusinh 2008, pp. 96, 103, 106, 247) and many more. One has to allow some leeway to the painters who were rendering the animals in a particular style, but there are precise studies such as the one in *St. Petersburg Muraqqa,* where the lion's rendering is as realistic as any by a modern day artist.

Quoting Bernier, Valmik Thapar says that "Except in Kathiawar, lions are now never met with in any part of India" in the mid-17th century. We are indeed most surprised to read this. We have checked *Travels in the Mughal Empire AD 1656-1668* by Francois Bernier, translated by Archibald Constable and revised by Vincent A. Smith, published by Oxford University Press, p. 378. The quoted sentence is a footnote by Vincent Smith or Archibald Constable, dated c. 1934 and not by Bernier himself!

Valmik Thapar quotes Professor Helen Basu: "In fact when the Nawab brought African lions to the Gir forest he also settled some sidis to take care of them." Sidis (Indians of African origin) are spread over in Saurashtra peninsula and elsewhere in Gujarat, Maharashtra, and Karnataka. When did the Nawab import lions and which Nawab of Junagadh did so from Africa to stock the Gir? What is the source of her assertion? Divyabhanusinh has made an extensive search in the Junagadh State records, but he has not come across any document pertaining to imports of African lions to stock the Gir or of the arrival of Sidis to take care of them.

It must be borne in mind that state records of the Junagadh state are available and the state affairs of the Sultanate and Mughal periods of medieval Indian history have been recorded by chroniclers of the likes of Abul Fazl and scores of others, in some detail. When the ruler in question was interested in hunting, as in the case of Fịroz Shah Tughlaq, Akbar, Jahangir, and others, details pertaining to the hunt are more in evidence in the various *Tarikh*s and *Nama*s. Only a prince keenly interested in hunting could have 'imported' lions or cheetahs for sport. Would such an event of importance in what was a passion or a prime pastime of the ruler not be recorded in his chronicles, especially when one considers that the import of exotic specimens such as the zebra, dodo, and the Barbary falcon not only find special mention, but were recorded in specially commissioned paintings?

The chapter 'The Last Lions' opens with a quote from Capt. Thomas Williamson's *Oriental Field Sports* and from its page 130 'As for lions there are none in Hindustan...' And only lion seen was the one from Ghod in 1781, presented to Governor-General Warren Hastings. The work was published in 1807 by Edward Orme. The reference says, "(New York printed for Edward Orme) P. 130". The bibliography on the other hand simply says, 'Ëdward Orme, 1807'. On checking the latter's facsimile reprint of 1987 by Anthony Atha Publishers Ltd., it was found that the said page deals with 'Plate XXXVI Killing Game at the Inundation of An Island'. The referred quote does not find place on it. The word lion does not appear in the index either. Thus, we are unable to check the context of the statement. It is hoped that this is not another attempt to mislead the reader. Incidentally, Valmik Thapar states in the epilogue of the book that Williamson did not come across any cheetahs and lions while out pig-sticking in Bengal. He was not likely to, as the two cats preferred a different kind of landscape and did not exist in Bengal during that period. Valmik Thapar, however, does not point out the fact that Williamson also gives a fairly long account of hunting with cheetah and caracal in the same work (Williamson 1807, p. 144). A two volume edition of the same book was published the next year, 1808, in which a drawing of a pair of cheetahs by Samuel Howett appeared as the frontispiece of the second volume (reproduced in Divyabhanusinh 2006, p. 82).

Valmik Thapar quotes Thomas Pennant who says that the environs of Rohtas and Gur (Gir?) have numerous lions. Pennant does not deny the existence of lions but refers to those who deny their existence and says that "here was a royal menagerie, and that the breed was propagated from the beasts, which had escaped". Who were these persons in denial? Referring to *Ain-i Akbari* which "is silent whether they had or had not been aborigines of Hindustan", Valmik Thapar thereby once more casts serious doubts about lions being 'aborigines' of Hindustan. The question: would Abul Fazl have neglected to record imports of lions? His work is a detailed description of the administration under Emperor Akbar and the Mughal Empire would have had to spend considerable sums to import them on a regular basis.

Sir Charles D'Oyly, the renowned Company School artist, painted a two volume album of shikar indulged in by the British, in what is now Bihar, Jharkhand, and West Bengal. It contained 63 water colour paintings, which had among others nine paintings of hog hunting, seven of tiger shooting, six of lion shooting, three of leopard shooting, and one of hunting with cheetahs (D'Oyly 1810–15). Valmik Thapar omits mention of this source, though his work is contemporaneous of Williamson.

Valmik Thapar quotes James Forbes's description of a lion shoot in 1781, which took place on the banks of Sabarmati, fifteen 'coss' from Cambay (Khambhat) in Gujarat. Yet, in his very next paragraph Valmik Thapar says, Forbes was convinced that lions existed only on the borders of Persia!

Valmik Thapar and Yusuf Ansari do not even surmise as to when they believe the imported cheetahs and lions escaped, as they claim, from captivity in ancient India, or if in the mediaeval period, whether during the Delhi Sultanate or the Mughal era. If Akbar did have the thousands of cheetahs in captivity as the records show and had they indeed been the progeny of feral animals, they must have become feral millennia ago to have bred in such large numbers to have become so widespread by the Mughal period. So were the lion and cheetah imported in ancient India and if so, in approximately what period and from where? This would also raise the question of trade and communication between India and Africa and the efficacy of vessels to transport large and dangerous carnivores such as the lion and cheetah, in that ancient era. Professor Thapar states categorically that there is no record of lions being traded in the ancient period. The same goes for the cheetah. We have also found no such record in the later periods as well, as noted earlier.

There is no doubt that in comparison with the tiger or the leopard whose numbers go into thousands being shot, the number of lions being killed is small. However, between 1820 and 1860, one can account for 494 lions killed for sport outside of Saurashtra (Kathiawar). These are the shikar records of Frazer, Smith, and in Bundi and Kotah (Divyabhanusinh 2008, p. 123). Joslin's figure of lions shot outside Kathiawar between 1863 and 1888, is another 37. There is no argument on this score, though there would have been several more lions killed and other encounters which would have gone unrecorded. But does this low number mean that the lions were non-existent or imported?

Valmik Thapar goes on to take the case of a 'Colonel A. Smith'. Presumably, he means Colonel George Ackland Smith. He says that he claims to have shot between 50 and 300 lions around 1857–58 around Delhi and Haryana. As usual, there is no reference to where the information came from. Actually, the story is somewhat different. Norman B. Kinnear, who was curator of the Bombay Natural History Society, wrote an authoritative paper in the Society's *Journal* in which he says, "Central India in these early days [early 19th century] was one of the strongholds of the lion and to give an idea of its numbers we may mention that Lydekker was informed that during the Mutiny [1857–58], Colonel George Ackland Smith killed upwards of 300 Indian lions and out of this number 50 were accounted for in the Delhi District" (Kinnear 1920).

Anyone is free to challenge this figure with proper research, but Valmik Thapar goes on to say that "during this period of unrest, many menageries were looted and scores of lions fled and that Smith may have succeeded in killing most of this tame and captive population. Some may have been

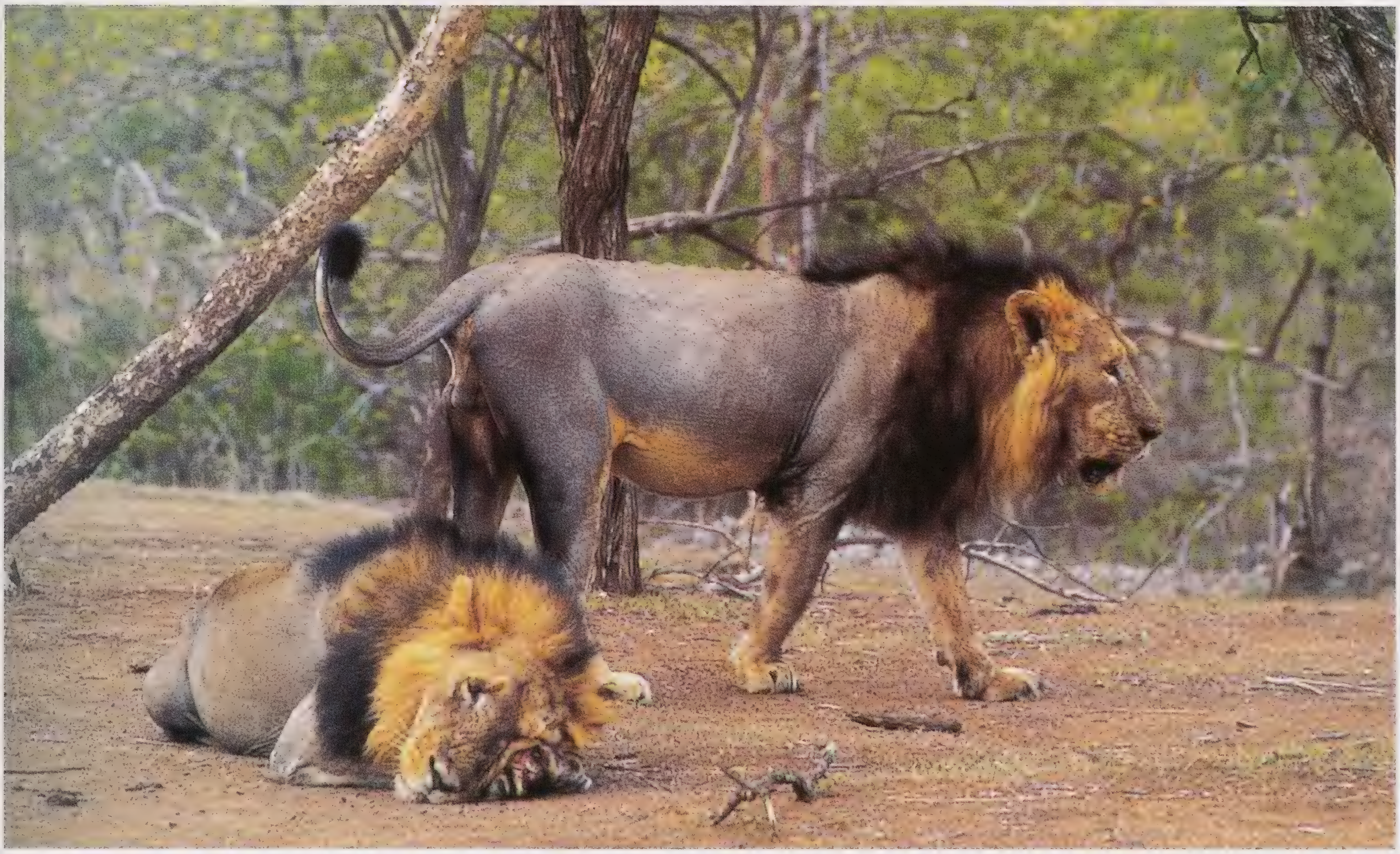

Fig. 5: A pair of mature black maned lions in the Gir, refutes the belief that Indian lion had only a sparse, light-coloured mane. Photograph: Divyabhanusinh. Reproduced from *The Story of Asia's Lions*, Marg Publications, Mumbai, revised and enlarged edition, 2008

killed in the private hunting parks of the local kings. There was a definite link between the bloody conflict and the death of lions". Again there is no mention of the source for this sweeping statment, or the grounds of his surmise.

Valmik Thapar also refers to animal traders like Hagenbeck (though the book of Rothenfeld from which he refers to Hagenbeck, is on the beginnings of modern zoos). The enormity of the trade in wild animals is mentioned, but there is no mention of supply of lions to the menageries of the princes in India, which were then allegedly used for release and shikar. He goes on to say "I believe Indian Royalty continued to import, tame and release lions into their game parks." No evidence is cited again.

Further on, Valmik Thapar says that few considered lion as an important part of India's natural world. This he says in spite of all natural history works of Jerdon, Blanford, Stuart-Baker, Sterndale, Finn, Lydekker, Pocock, Prater, and others, which include the lion as a natural habitant of India!

Valmik Thapar goes on to state that when Prince Albert Victor, the Duke of Clarence went to Gir to shoot a lion in 1890, he was offered East African lions which would be made available and two lions were said to have come from Junagadh, sent by the Diwan of Junagadh, but the offer was declined. We are at a loss to find the source of this information. Col. L.L. Fenton, who was present during this shoot simply records that the Diwan Haridas Viharidas of Junagadh suggested that the two lions sent from Junagadh during the night, may be shot. In the event, the offer was refused. There is no mention of these animals being from East Africa (Fenton c. 1924, pp. 21–22).

The chapter ends with the statement that "At this point the 15–20 lions that were left in the Gir were intensively managed and reared by the Nawab of Junagadh in his private hunting grounds. As a result of this, their population slowly rose." To start with, the figure of 12 to 20 was misleading and has been challenged by the official historians of Junagadh State. In fact, Nawab Rasulkhanji himself contradicted the rumours (Edwards and Fraser 1907, p. 173; Divyabhanusinh 2008, pp. 178–179). L.L. Fenton who was in the Gir and in Kathiawar (Saurashtra) in 1899 during the great famine, expressed no such alarm except to say that the lions were by then found only in the Gir (Fenton *c*. 1924, pp. 1–30). There is no evidence whatsoever of the Nawab 'rearing' lions. In view of the intense pressure on the Junagadh Darbar to issue lion shooting permits to British and princely hunters who wanted lion trophies, Junagadh usually pronounced exaggerated lowly numbers of the lion to turn down the requests (Divyabhanusinh 2008, pp. 180–181).

The chapter 'The Age of Slaughter' deals at length with the depredation of the British and the Princes. There is, however, a detailed account of Maharaja Madho Rao Scindia's failed attempts to introduce African lions in the wilds of Gwalior state. This is the only such attempt known in India, yet the author insists that it was "like many others had probably done before him"! Further, he goes on to say that Gwalior was not interested in Junagadh's "leftovers" but wanted the black maned lions from Africa. This is false. Actually, Maharaja Madho Rao Scindia caused the British Political Agent at Gwalior to write to the Political Agent in Kathiawar for help in obtaining lions from Junagadh. The latter made the request to Rasulkhanji. The Nawab personally wrote back to the Political Agent to say that "the number of the noble animals which was never very large has been so much reduced of late…" because of various reasons including the great famine of 1899–1900, illegal shooting, etc., he was not in a position to spare his lions for Gwalior. It was only after this rejection that Gwalior brought African lions (Divvyabhanusinh 2008, pp. 190–191). Besides, Gir lions also have spectacular black manes (Fig. 5). In the footnote to Valmik Thapar's reference on page 255 of the book for page 169, on which the Gwalior account appears, he says, "I believe the regions between Agra and Gwalior are areas in which lions have been bred since the Mughal era". What is the basis of this belief? The point to be noted is that Gwalior was one of the largest states in India with an area of over 26,000 square miles. Yet, it failed to introduce African lions in spite of its vast forests and resources. Were the other princes, almost all of whom were smaller and less resourceful, likely to succeed where Scindia failed?

Further on, Valmik Thapar refers to Jean de Thevenot and says that he is very clear that cheetahs were trained in Gujarat, etc. This has been examined earlier, along with *Mirat-i Ahmadi.* Then he goes on to say "I am sure they were unloaded, at the harbor, acclimatized [Schimmel's word examined earlier] and trained there." The question is where is the Mughal period record of the cheetah trade for the court, with the animals landing at a harbour in Gujarat or elsewhere? Of course, cheetahs were caught from the wild in Gujarat, trained and sent to court at Delhi. There were sufficient cheetahs in the wild in India for a profession to develop for catching them and selling them for purposes of hunting. The Pardhi tribe took to it. These tribal people were known by their trade and divided into professional groups. For example, 'shikar pardhis' were ones who used firearms to hunt; 'phase pardhis' or 'hiranshikaris' were hunters of antelopes; 'tilwale pardhis' were ones who sold crocodile oil; 'cheetawale pardhis' were ones who trapped cheetahs in the wild, to supply them to royalty and, therefore were also known as 'raj pardhis' (Kennedy 1908, pp. 133–134; Russell and Lal 1916, pp. 360, 366–367). The question to be asked is how many cheetahs were in the wild and how long and how many generations of the pardhi profession it took, to evolve into these specific profesional groups?

Valmik Thapar refers to the cheetah book of Divyabhanusinh, which states that Tipu Sultan's cheetahs could have been imported but was unlikely. He quotes the same book further to state that trained cheetahs along with caracals, lynxes, falcons, and hawks may definitely have reached the menageries of Muslim invaders from Central Asia or Persia. The emphasis is on the word 'may'. It is a conjecture and there is no evidence to support it.

It would be important to consider some other evidence. A recent paper by Manamendra–Arachchi *et al.* (2005) has reported new fossil evidence. To quote from the abstract of the paper: 'Tigers appear to have arrived in Sri Lanka during a pluvial period during which sea levels were depressed, evidently prior to the last glacial maximum *c.* 20,000 years ago. The lion appears to have become extinct in Sri Lanka prior to the arrival of culturally modern humans, *c.* 37,000 ybp' (Manamendra *et al.* 2005). Another source too has recorded a single fossil lion tooth in Sri Lanka (Sunquist and Sunquist 2002, p. 286; Deraniyagala 1958). A fossil broken mandibular ramus containing a molar and the fourth premolar of a lion (*Panthera* cf. *leo*), together with the fossil remains of the spotted hyena (*Crocuta* cf. *sivalensis*), have been found in the oldest alluvial Pleistocene deposits (*c.* two million years old), near Susunia, Bankura district, West Bengal (Dutta 1976).

A study of the evolutionary dynamic of the lion concludes that by the Mid Pleistocene, lions had already occupied Europe, having proliferated from Africa and by the Late Pleistocene (*c.* 130,000–10,000 years ago), lions had the greatest intercontinental distribution for a large mammal (excluding man), ranging from Africa into Eurasia and the Americas (Antunes 2008). It is essential to look at the climatic conditions and aridity of Sindh and Punjab during this period, before concluding that the Indus was a barrier to lion dispersal.

This brings us to the cheetah. A recent study by Charruau *et al.* (2011) has concluded that the genetic variation in the current global cheetah population is more than previously described. It goes on to state "The total nuclear (microsatellite) diversity (H_E-0.766) is comparable with that of other out bred felid species… The lower H_E0.397 observed in the Iranian cheetahs might be the consequence of ancestral population divergence or a recent effective population size reduction in this population… Remarkably, the North Eastern African cheetahs were highly differentiated (nuclear F_{ST}=0.170) from the Southern African individuals and clustered independently and monophyletic". From this, the study concludes that "Iranian cheetah are an autochthonous monophyletic population and the last representatives of the Asiatic subspecies" (Charruau *et al.* 2011). Ignoring this study, Valmik Thapar states, as we have noted earlier, that it would be 'facile' to consider Asiatic cheetah to be indigenous to Iran. How is it that the book does not take into account and challenge these and other such studies on the two large cats, but ignores them to reach what, apparently, are preconceived conclusions?

Regarding the genetic evolution of the Asiatic cheetah, the remarks of Dr. Y.V. Jhala are very pertinent: "The authors of *Exotic Aliens* thankfully do not doubt the indigenous nature of India's endemic antelope, the blackbuck. The blackbuck is the fastest land mammal on the Indian soil and this speed is believed to have co-evolved to keep pace with predation pressure from a faster predator, the Asiatic Cheetah. A similar coevolution occurred between the Pronghorn and the North American Cheetah (which became extinct about 15,000 years ago), the pronghorn evolved its high speed under predation pressure from the cheetah. With the extinction of the cheetah in North America and India, the blackbuck and the pronghorn do not have any predators that can match them in speed. Such coevolution takes place over millennia where natural selection shapes such traits in species." It is unlikely that coursing by captive tame imported cheetah was responsible for evolving the speed of blackbuck over the few hundred years! Considering the evolution and range expansion pattern of cheetah based on latest genetic research (Charruau *et al.* 2011), the Iranian and Indian cheetah form a monophyletic clade along with cheetah from the Arabian peninsula and Egypt that separated from their African cousins some 10–35 thousand years ago. Thus, the Asiatic cheetah has distinct mitochondrial and nuclear DNA signature closer to cheetah from North Africa but distinct from lineages in the rest of Africa. The North African and Asiatic cheetah were similar both for nuclear and mitochondrial markers and seem to have been derived directly from the ancestral populations in southern Africa. The East African cheetah form a cluster distinct from the North African and Asiatic cheetah (Charruau *et al.* 2011). If cheetah were imported into India from Africa by sea as proposed by the authors of *Exotic Aliens*, their DNA would align them with the East African lineage and not with the Asian lineage. Thus, molecular taxonomy identifies the Indian cheetah to have originated from the Asiatic lineage.

"Understanding of biogeography, ecology and genetics suggests that a) Ethiopian fauna and flora including leopards, lions, cheetahs, striped hyenas, honey badger, caracal, acacias, and antelopes came into India from Africa through Persia, b) distances between Persia and India could easily be traversed by highly mobile species like the lion and cheetah. A Gir lion tracked by satellite telemetry covered over 150 km in 3 days. Dispersing individual cheetah from Iran have been recorded well into the western border of Afghanistan and into Pakistan until recently. There are no physical barriers to dispersal for these species into India, as even plant communities and antelopes came into India via this route" (Jhala pers. comm. 2013).

Valmik Thapar calls Asiatic lions a '*khichdi*'. We all know it means a mixture. Actually, all the phylogenetic and geographical evidence suggests that the Asiatic lion is a distinct sub-species, reflecting an ecological separation of many millennia, which also shows some features of inbreeding, according to Stephen O'Brien. So how are they a 'khichdi'? Let us look at O'Brien's statement which finds no place in Valmik Thapar's book:

'Around twenty-five hundred years ago the Gir [Saurashtra] peninsula was actually an island surrounded by rising waters. The ancestral founders of the Gir lion population were isolated from the larger mainland lion population, and due to small numbers they suffered inbreeding over several generations. Hunting and habitat occupation by human developments had effectively extirpated the larger lion populations over this period, leaving only Gir lions to occupy once the peninsular water receded' (O'Brien 2003, p. 51). Apart from the lions not being 'khichdi', they were part of a larger population twenty-five hundred years ago, in the Saurashtra peninsula.

The question arises that if the lion in India was indeed imported as is claimed, there should be no genetic difference between the African and Indian lion, which today are classified zoologically as *Panthera leo leo* (nominate African subspecies) and *Panthera leo persica*, the Asian lion. If this genetic difference is accepted, that would be a death-knell to the whole contention that the lions were imported, because even if the postulation of lion import from the era of Alexander the Great is accepted, genetic changes that would warrant the evolution of a new subspecies are not possible in a span of 2000 years. So Valmik Thapar circumvents this obstacle by stating that 'The superficial differences between the Asiatic or Indian lion and the North African lion are probably an adaptation to the Indian climate, environment and inbreeding; there is little possibility of it qualifying as a distinct subspecies.'

In this regard, the observation of Dr. Y.V. Jhala is significant: 'The Indian lion differs in its skeletal (Skull) and body morphology from its African counterpart (O'Brien *et al.* 1987). Such differences occur in nature when populations are separated for several thousands of years. Occasional mixing of the populations resulting in exchange of genetic material between populations does not permit such traits to diverge between populations. Studies on lions show that modern lions evolved from East and southern Africa about 200,000 years ago and spread to the north in two separate waves, about 100,000 and 10,000 years ago. During the first wave of dispersal, the lions crossed the current Sahara barrier (which was then forested) to Northern Africa and into Persia and then onto India, some 28,000 to 100,000 years ago. This theory is supported by data from allozyme electrophoresis (O'Brien *et al.* 1987) and mitochondrial and nuclear genes of lions (Antunes *et al.* 2008; Barnett *et al.* 2006). There is no evidence of genetic mixing between the North African-Asian Lineages with those found in other parts of Africa (Antunes *et al.* 2008). The authors of *Exotic Aliens* postulate that lions were brought into India as human imports that went feral and that such events occurred on several occasions in historical times, resulting in a "*khichdi*" or a "mongrel" breed of Indian lions. If that were the case, then Indian lions should either have East African genetic lineage or be a mixture of North African-Persian and East African lineages. However, all Indian lions analyzed till date form a distinct genetic cluster with their closest living relatives being the lions from the Atlas Mountains and Morocco, the only living relicts of the North African clade. They are distinct from East African lineages and nor do they have a mixed lineage. Also, the Indian lions have unique mitochondrial haplotypes that have been derived from African lions but differ by several mutational steps. The mutation rate of mitochondrial markers is considered to be about one in 7000 years and this molecular clock puts the time of divergence of Indian lions from their African cousins to be between 70 to 130 thousand years ago. This data clearly shows that Indian lions are relics of a natural colonization event that occurred much before human imports of lions could have started and that they represent a unique evolutionary trajectory of lion lineage that is ancient and merits serious conservation efforts. The genetic data also rules out the proposed hypothesis that imported lions from Africa became feral and interbred, as the current Gir lions are a pure and distinct lineage and not a "*khichdi*" as proposed by *Exotic Aliens*. Though closely related to the North African lion, they do form a distinct and unique clade by themselves.' (Jhala, pers. comm. 2013).

It is evident that the authors of the book have not studied in any detail the biogeography of the Indian subcontinent, nor do they put forth compelling evidence or cite irrefutable original sources to support their contentions. Merely stating 'I believe…', 'I am sure…', 'as far as I am concerned…' and such like without adequate proof to support their surmises, is neither scientific nor adequate, especially if the authors wish to establish their theory in the face of empirical evidence to the contrary, including fossil and archaeological bone data. Besides, giving demeaning titles like 'mongrels', 'khichdi', 'impostor', 'facile' and others to the purported 'exotic aliens' can give no credit either to the book or to its authors. Denigrating a species in comparison with another does not elevate the status of the preferred species and no species, let alone the magnificent tiger, requires such contrived one-upmanship. Propounding a theory merely on the basis of surmises repeated ad nauseum, unsupported by any valid proof, cannot be deemed to be a treatise on natural history, let alone a scientific document.

After careful perusal of the book *Exotic Aliens: The Lion and the Cheetah in India* we have come to the conclusion that it has been written to support a preconceived notion and to buttress the image of one iconic species. Raising a controversy is a good way of ensuring success of a publication and of garnering publicity. With the evidence placed forth in this paper, the question would arise as to who is the 'imposter', the book *Exotic Aliens* or the lion or the cheetah in India? Let the reader decide.

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BEHAVIOURAL ETHOGRAM OF THE GREAT INDIAN BUSTARD *ARDEOTIS NIGRICEPS* (VIGORS 1831)

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The Great Indian Bustard *Ardeotis nigriceps*, a large ground-dwelling bird of India and Pakistan, is declining throughout its entire range. Little has been published in detail on the behaviour of this species. This work presents an ethogram of the species describing 63 individual behaviours grouped under 11 broad categories: alert, resting, comfort and maintenance, locomotion, ingestive and excretory, antagonistic, interspecific response, sexual, maternal, vocalizations, and reflexes.

National and site-specific recovery action plans for Great Indian Bustard are in process and *ex situ* conservation is one of the proposed measures. A better understanding of Great Indian Bustard behaviour is essential for both *ex situ* and *in situ* conservation. Precise descriptions of behaviours presented here provide a standard that can be used for systematic and quantitative study of behaviours of the species and which could be of significance in *ex situ* breeding.

Key words: Great Indian Bustard, ethogram, *in situ* conservation, conservation breeding, *ex situ* conservation, behaviours, captive breeding

INTRODUCTION

The Great Indian Bustard (GIB) *Ardeotis nigriceps* is endemic to the Indian subcontinent, distributed in India and Pakistan (Ali and Ripley 1980; Rahmani 1989). The species typically inhabits arid and semiarid landscapes dominated by open grasslands interspersed with short shrub and extensive agriculture. Sexual dimorphism in size is very evident in the GIB, with adult males standing up to 1.1 m. The female is smaller at 0.9–0.92 m. It is a polygynous species. It breeds principally between March and September, differing regionally, based on rainfall (Ali and Ripley 1980; Rahmani 1989). Breeding males establish territories using an exploded lek mating system (Ali and Ripley 1980; Dutta *et al.* 2010; Morales *et al.* 2001; Rahmani 1989). The GIB was subjected to an in-depth, long-term study by the BNHS in the 1980s, which provided information on the population, distribution, and ecology of the species and its conservation issues (Rahmani 1989). However, over the years, its population has been dwindling rapidly, with a decline approaching 75% within three generations (Dutta *et al.* 2010). With a current population of not more than 300 birds, the predicted extinction probability is very high within the next three generations (Dutta *et al.* 2010). Additionally, the low diversity of mitochondrial DNA across the Indian population suggests a strong population bottleneck event in the past (Ishtiaq *et al.* 2011).

For the above reasons, the International Union for Conservation of Nature (IUCN) and BirdLife International uplisted the status of GIB to Critically Endangered (CR) category (BirdLife International 2012). The various identified threats to GIB survival are habitat loss, mismanagement of habitat, agricultural changes, overgrazing, hunting, failure of breeding because of increased disturbance (BirdLife International 2012; Dutta *et al.* 2010; IUCN 2008; Rahmani 1989, 1996, 2006), and heavy poaching in Pakistan (Khan *et al.* 2008). Even though the GIB has been the subject of intensive studies, little has been published on the behaviour of the species. To fill this lacuna, we present a description of various behaviours of GIB with the use of ethograms. A greater understanding of behaviour is important in the development of effective *in situ* and *ex situ* conservation strategies for the GIB and will be invaluable for any captive breeding programme. Ethograms help in the comparison of various behaviours between related species (Xiao and Wang 2005). The need to interpret the evolution of adaptive life history strategies and reproductive systems within the framework of phylogenetic history (Pitra *et al.* 2002) can be fulfilled by comparing various ethograms.

METHODS

The behaviours described in this paper are based on published sources (Bhushan and Rahmani 1992; Manakadan and Rahmani 1990; Rahmani and Manakadan 1987, 1988; Rahmani 1989, 1996; Vyas *et al.* 1983) and from incidental observations on behaviour carried out by the first author at Nannaj, Maharashtra, totalling 1,400 ha, from 2004 to 2010. Observations were made from 06:00 to 19:30 hrs throughout the daylight period. The focal individual was observed with binoculars for durations of five minutes, and during the intervals, the behaviour seen was documented in detail with the help of sketches. Information from literature was used to supplement descriptions. Courtship calls of male GIB were recorded with a microphone ME 62 and Telinga universal parabolic dish. Marantz PMD 222 cassette recorder and Maxell type II cassette were also used.

RESULTS

We describe 63 individual behaviours, grouped under 11 broad categories: alert, resting, comfort and maintenance, locomotion, ingestive and excretory, antagonistic, interspecific response, sexual, maternal, vocalizations, and reflexes.

1. Alert Behaviour

GIB in alert mode remains stationary, either sitting or standing with eyes open and neck extended (Fig. 1). On rare occasions, one foot is raised slightly off the ground.

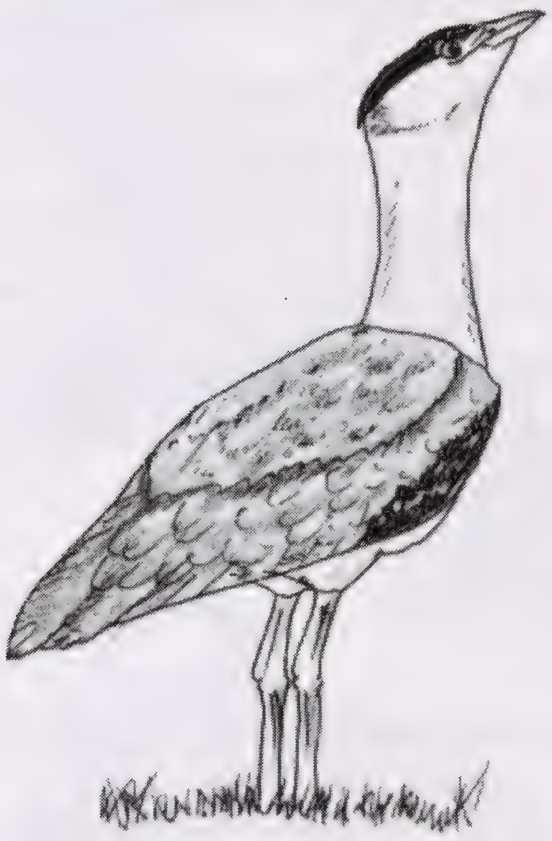

Fig. 1: Alert

2. Resting Behaviour

Four types of resting behaviour were observed:

i. **Resting**: The bird either sits on the ground or stands, with eyes closed. The neck may be tucked into the back or just lowered (Fig. 2). Resting is done during the hotter part of the day under the shade of bushes (*Ziziphus* sp. or *Carissa* sp.), small trees (*Acacia* sp.), or in isolated clumps of tall grass.

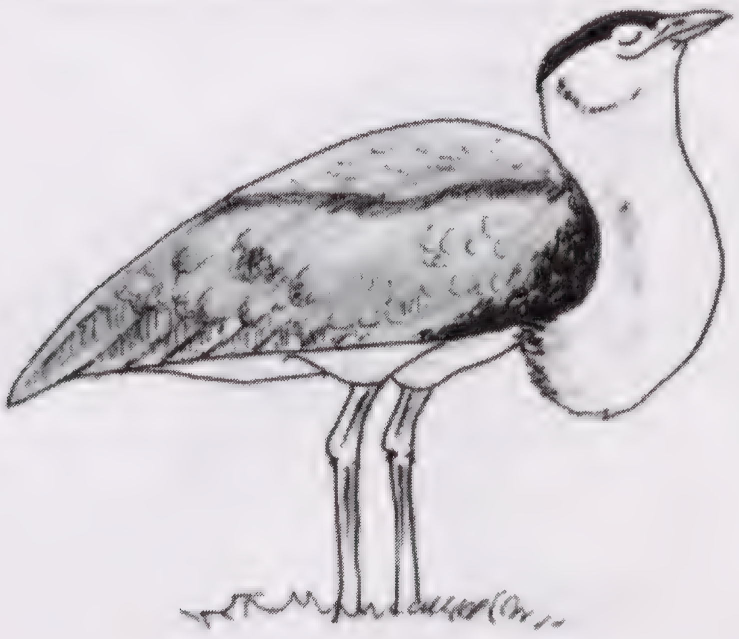

Fig. 2: Resting

ii. **Roosting**: The bird squats with its tarsi and belly on the ground. The neck is raised initially and then tucked into the back. Roosting was seen on the ground in comparatively bare areas.

iii. **Hock-sitting**: The bird sits with its tarsi and feet on the ground, tibio-tarsal joint flexed and tibiae vertical. The belly is raised above the ground (Fig. 3). Birds usually hock-sit while drinking (see Drinking) and when sitting amidst tall grass.

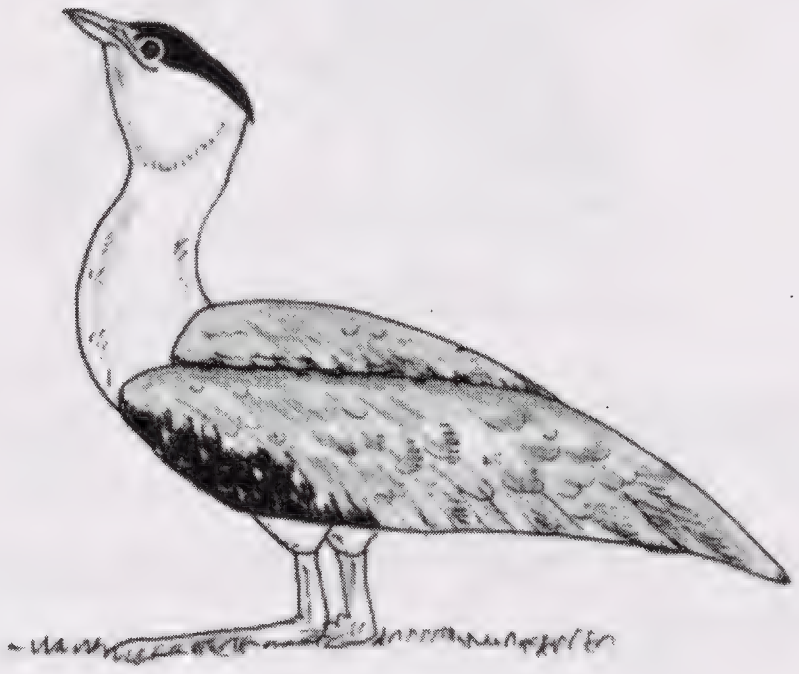

Fig. 3: Hock-sitting

iv. **Sheltering during rain/bad weather**: During periods of moderate to heavy rain, birds stand still with neck partially lowered or tucked into the back. During stormy weather, birds often stand under a bush.

3. Comfort and Maintenance Behaviour

This includes behaviour related to personal maintenance and comfort. Comfort behaviour can be divided into 15 categories.

i. **Scratching**: While standing on one leg, the upper neck and head areas are rubbed using a toe with three to five rapid strokes, at one instance. Neck and head are lowered to bring them close to the toe (Fig. 4). When scratching, the eyes are often closed and there is partial erection of head and neck feathers.

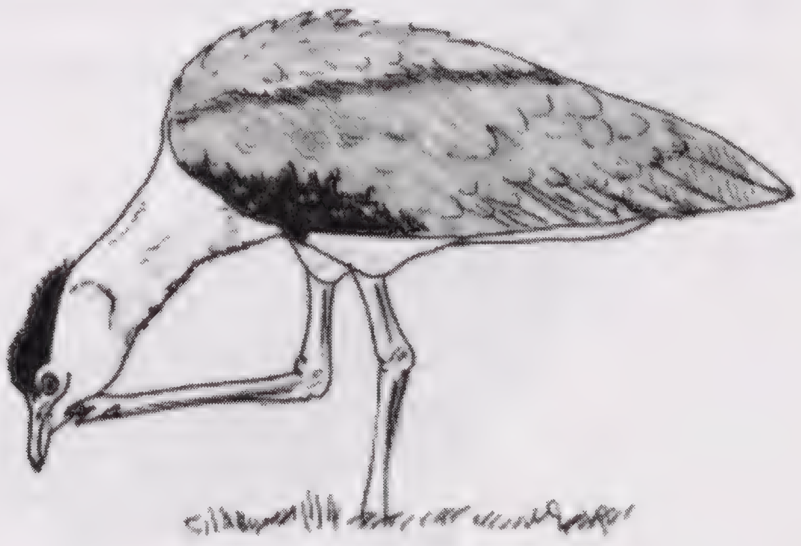

Fig. 4: Scratching

ii. **Wing and leg stretching**: The wing and leg on the same side of the body are extended together in a downward direction (Fig. 5). Stretching was often observed after a prolonged rest, or after incubation in females (see Incubation).

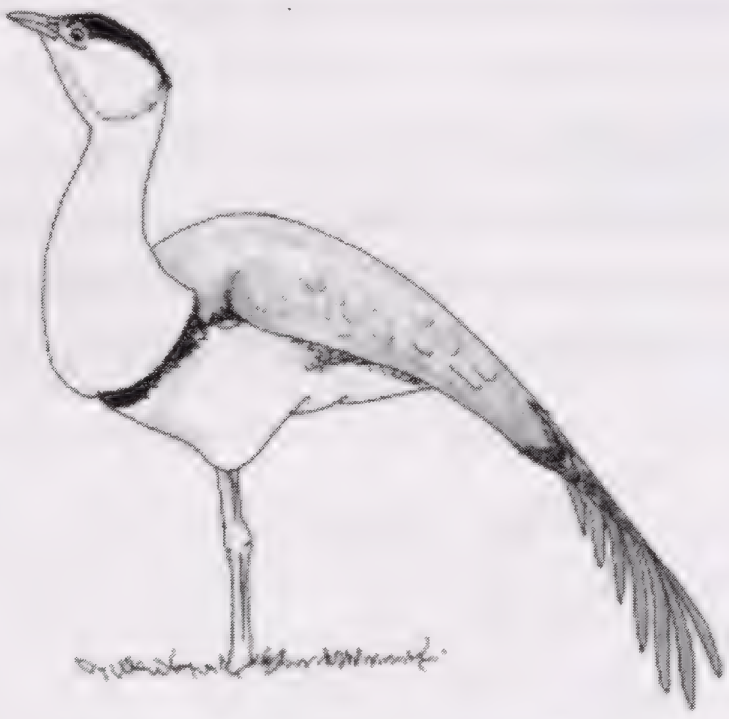

Fig. 5: Wing and leg stretching

iii. **Bow stretching**: Both wings and neck are stretched together, the neck is extended horizontally forward, the body and tail are slightly lowered and the wings are raised above the body (Fig. 6).

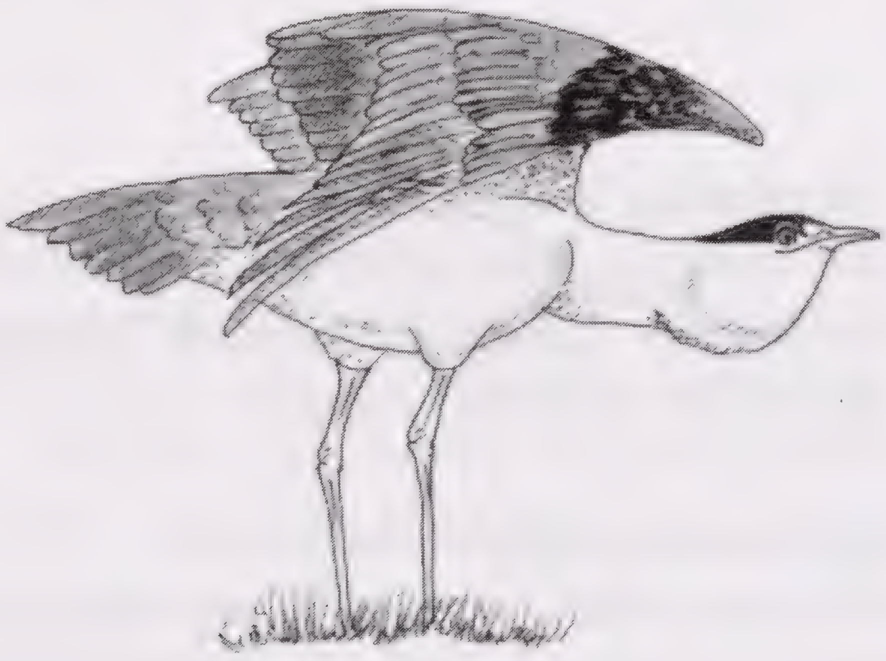

Fig. 6: Bow stretching

iv. **Jump stretching**: The bird leaps slightly into the air, extending and flapping its wings at the same time.

v. **Body fluffing**: The feathers on the crest, neck, wings, and back are erected and then smoothed down (Fig. 7). Body fluffing lasts only for two to three seconds, and is often followed by a gentle ruffling of the feathers (see Ruffling).

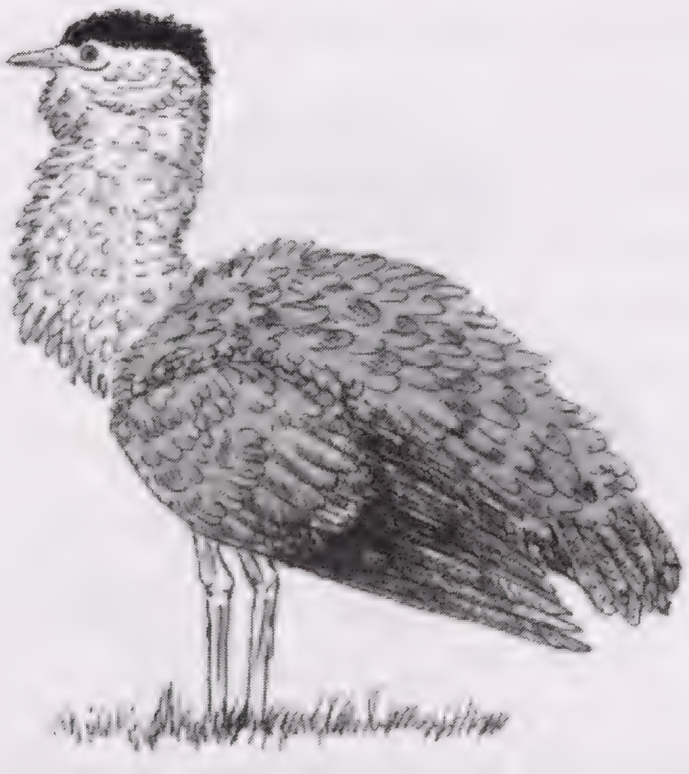

Fig. 7: Body fluffing

vi. **Ruffling**: With a wave-like movement passing from head to tail, the bird shakes its body with simultaneous fanning of tail feathers.

vii. **Wing flapping**: The bird extends its wings and flutters them several times. The neck is stretched vertically, along with erection of crest and neck feathers (Fig. 8).

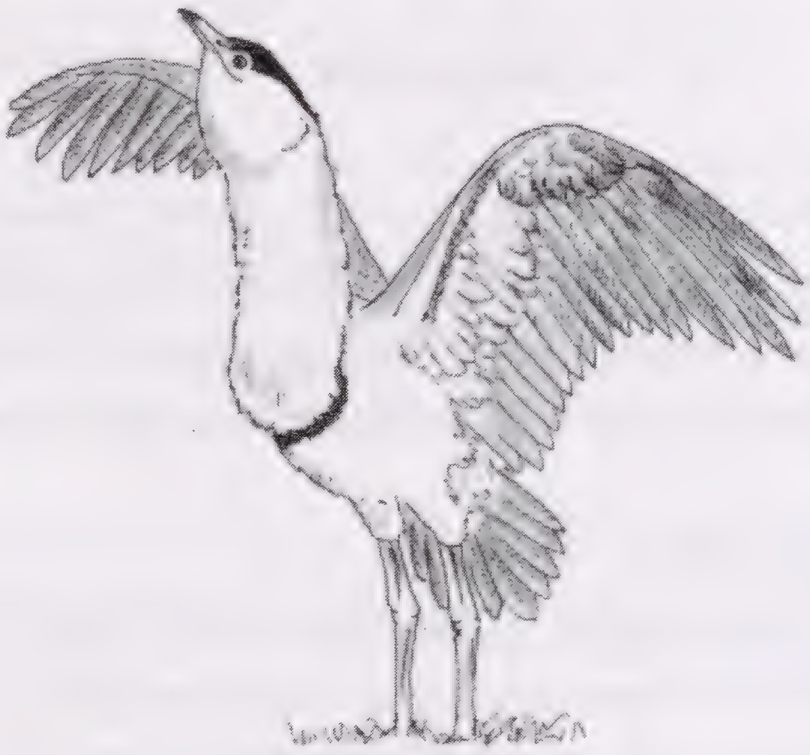

Fig. 8: Wing flapping

viii. **Preening**: It grooms the feathers on the neck, breast, belly, back, tail, legs, and wings, using a closed bill and moving down through the feathers, sometimes with short and rapid biting movements (Fig. 9). The eyes are usually closed during preening. Eyes are opened as soon as the bill is taken out of the feathers. Preening is often done during resting.

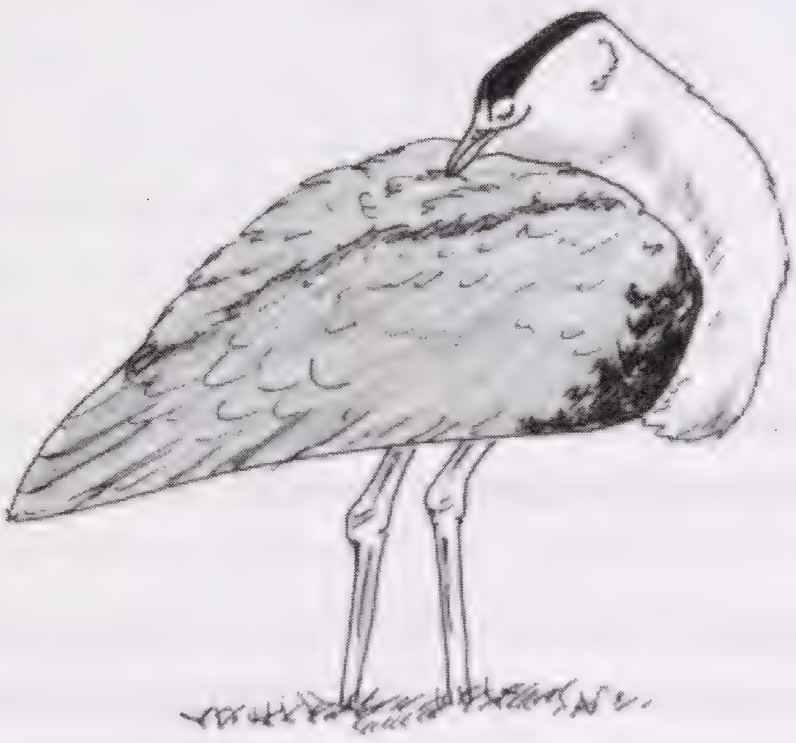

Fig. 9: Preening

ix. **Toe cleaning**: While standing on one leg, the bird pecks at a toe or nail of the other leg using its bill (Fig. 10).

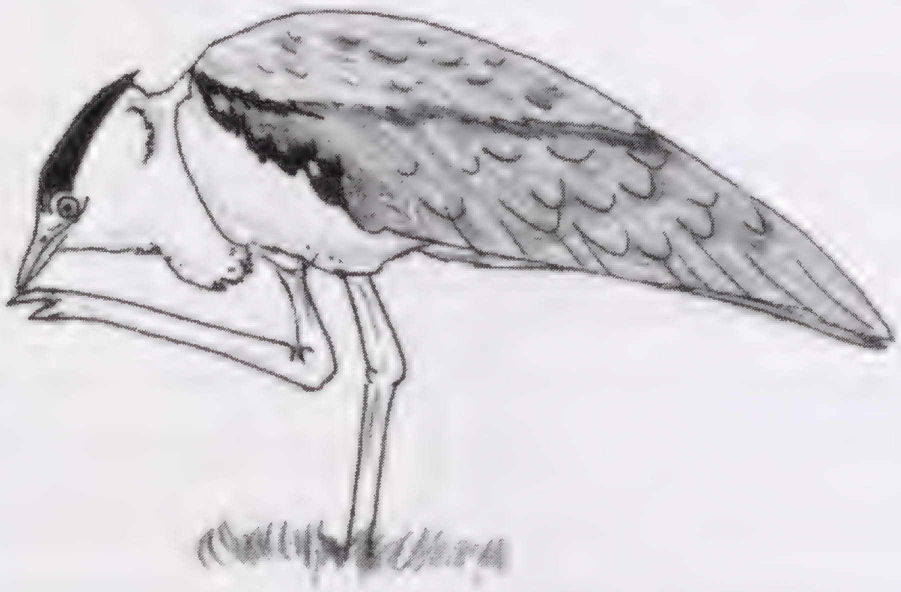

Fig. 10: Toe cleaning

x. **Dust bathing**: The bird rubs its belly, neck, and wings, and ruffles feathers in a dry dusty area (Fig. 11).

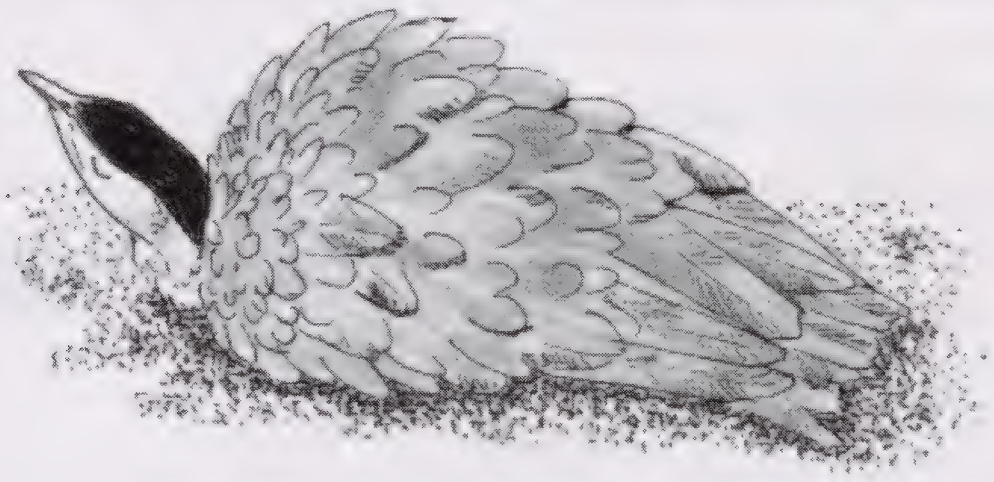

Fig. 11: Dust bathing

xi. **Wing-spread sunning**: The bird sits in short grass clumps in the sun with both wings horizontal to the ground (Fig. 12). This appears to have a thermoregulatory function as it was observed only after ambient temperature had risen. Wing-spread sunning is sometimes accompanied by panting (see Panting). It is often followed by preening.

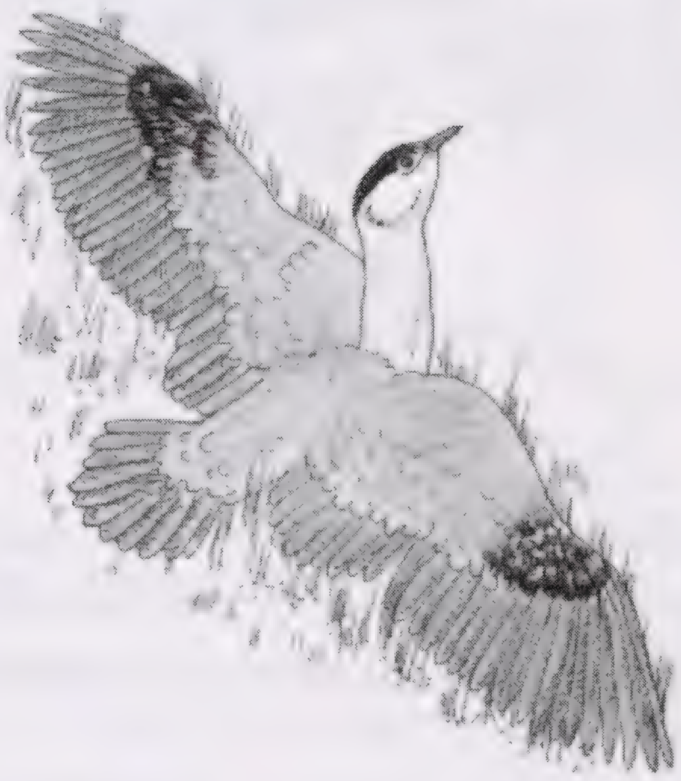

Fig. 12: Wing-spread sunning

xii. **Bill gaping**: The mouth is briefly opened wide as if the bird is yawning.

xiii. **Bill open**: The bill is held partially open for several seconds, the function of which is unclear.

xiv. **Panting**: The bill is slightly open, while the gular skin moves back and forth (also known as gular flutter) (Fig. 13). Panting is mostly observed in resting birds during hot weather. It is a thermoregulatory behaviour.

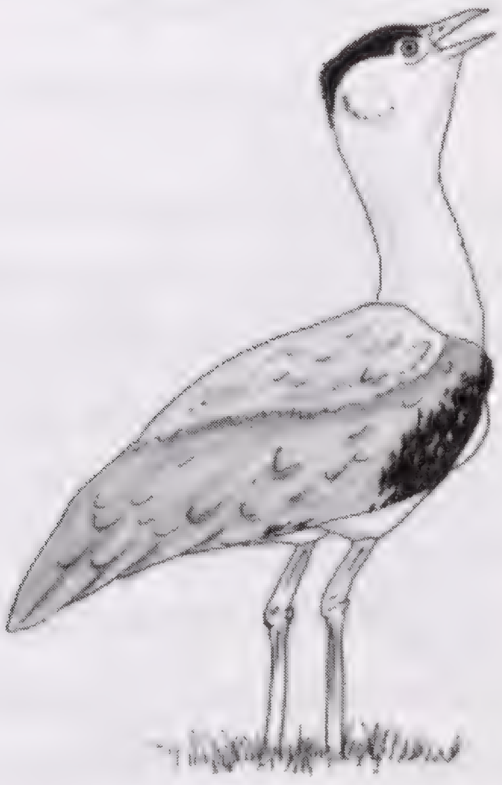

Fig. 13: Panting

xv. **Drying**: Drying happens soon after the rains stop. The tail is raised vertically and is accompanied with fanning of the tail feathers. Both wings are drooped (Fig. 14). Body feathers are ruffled frequently (see Ruffling).

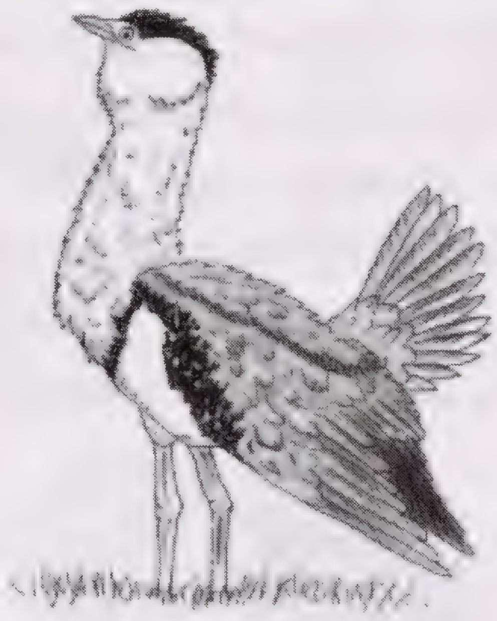

Fig. 14: Drying

4. Locomotion

Locomotion can be divided into five categories:

i. **Walking**: The bird strides about at an easy pace while moving about (Fig. 15). Walking is the primary mode of locomotion in the GIB.

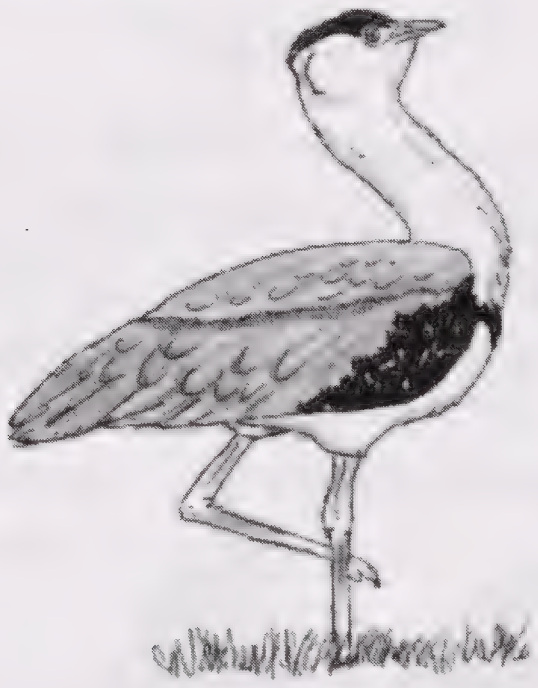

Fig. 15: Walking

ii. **Brisk walking**: GIB moves away quickly from a perceived threat, e.g., humans, cattle, or stray dogs. The head is raised in order to observe the intruder constantly while walking. Brisk walking continues until the bird no longer perceives a threat.

iii. **Running**: The bird moves at a faster pace than brisk walking. Its head may be held high and extended. The wings may be extended or held close to the body (Fig. 16). The run is short and if the threat persists, it takes to flight.

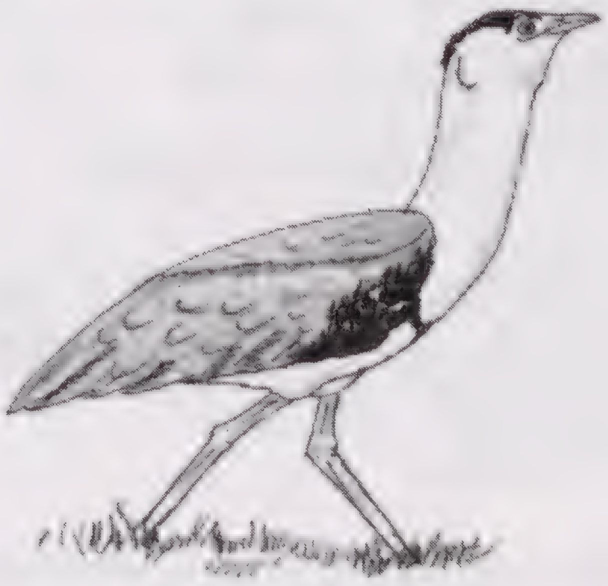

Fig. 16: Running

iv. **Flying**: Flying occurs following a short run or a jump. Usually a short run consists of four to five steps, followed by the opening of wings and stretching of neck. The body is lifted into the air with strong rapid wing movements. Once in the air, GIB is a strong flyer. While flying, the neck is fully extended and the legs are held extended in line with the body. GIB flies with constant and steady wingbeats. No soaring, hovering or gliding was observed (Fig. 17). Though GIB is a strong flyer, it prefers to walk and flies only when disturbed.

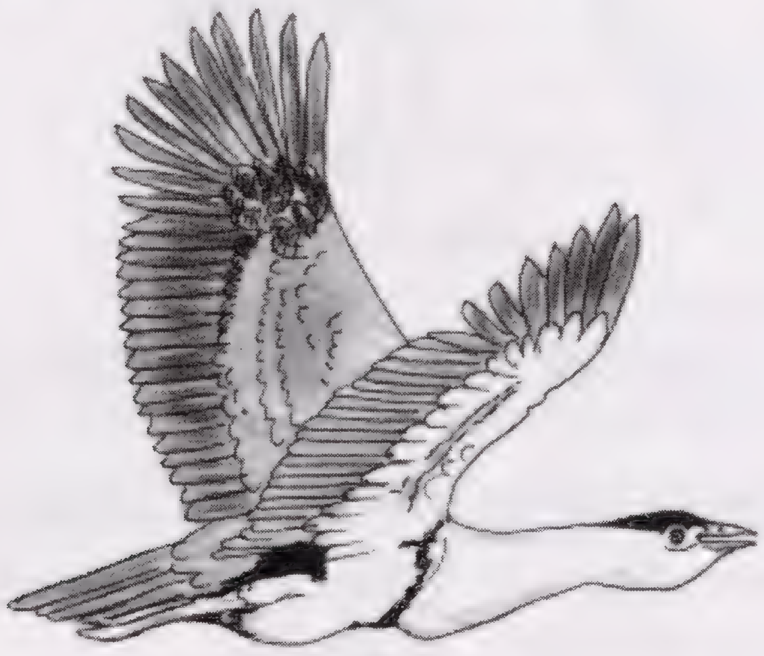

Fig. 17: Flying

v. **Jumping and flying**: Jumping followed by flying with rapid wingbeats occurs when the bird takes to the air (Fig. 18) to escape terrestrial predators, e.g., Wolf *Canis lupus*, Golden Jackal *Canis aureus*, and village dogs encountered at close distance.

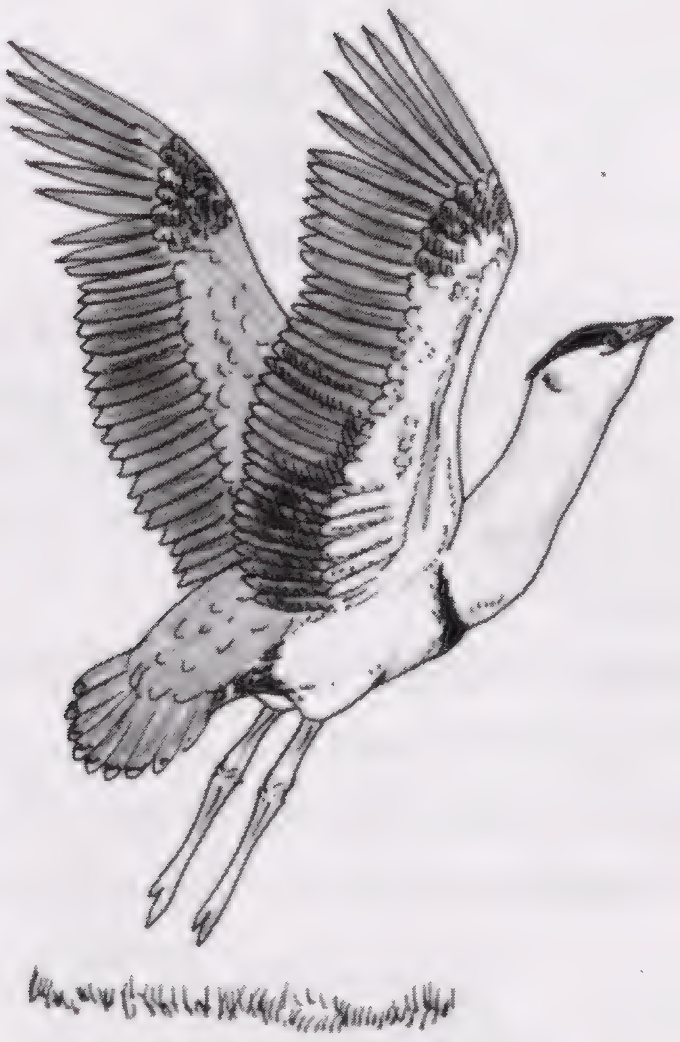

Fig. 18: Jumping and flying

5. Ingestive and Excretory Behaviour

Ingestive and excretory behaviours are divided into five types:

i. **Drinking**: The GIB drinks while hock-sitting, using a sucking method. Keeping the neck parallel to the water level, the beak is submerged to draw the water. The head is then raised to gulp down the water (Fig. 19).

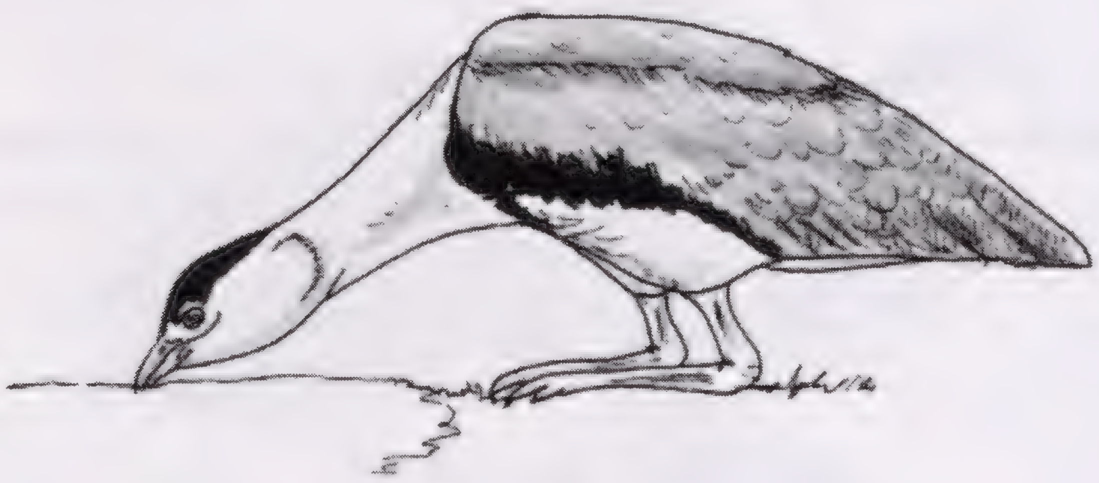

Fig. 19: Drinking

ii. **Foraging and feeding**: GIB searches for food while walking, looking down at the ground (Fig. 20).

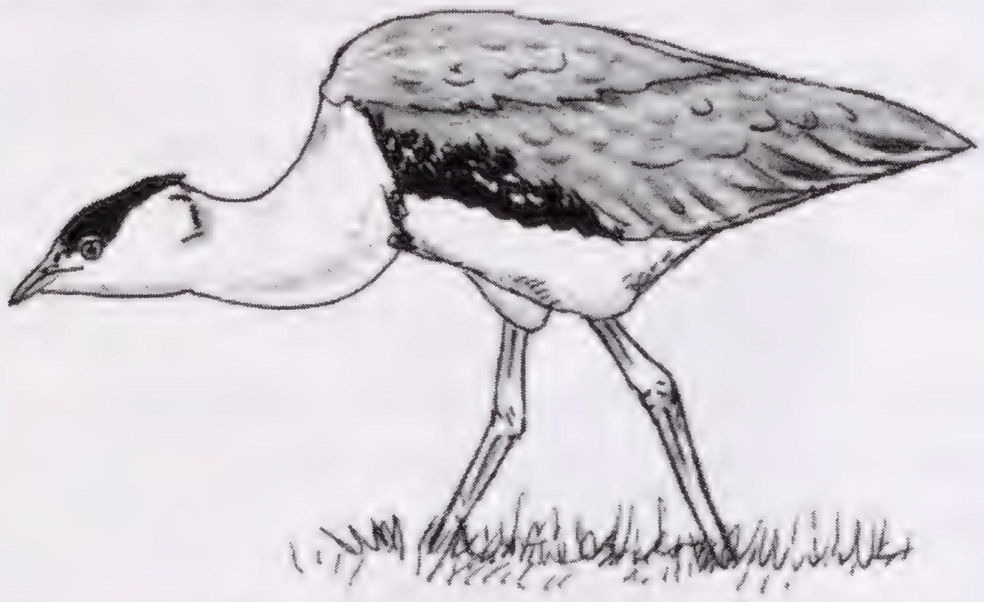

Fig. 20: Foraging and feeding

While walking, various types of insects are flushed from the ground. Once detected, the bird pecks at the food within reach. Jumping, running, or flying prey is chased and grabbed with the bill (Fig. 21).

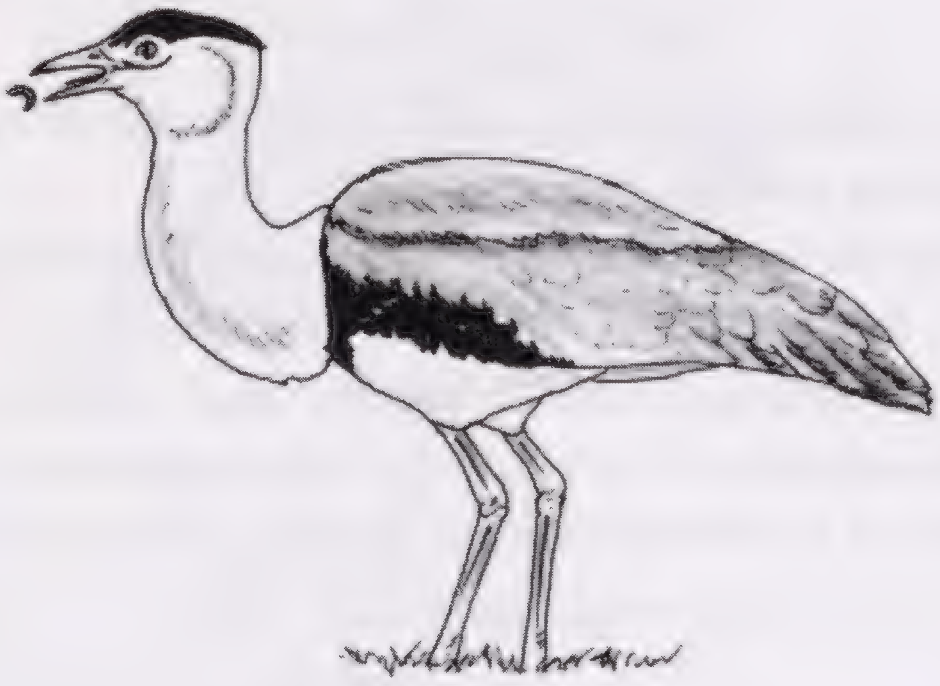

Fig. 21: Foraging and feeding

iii. **Eating grit**: GIB eats gravel and small pebbles to aid digestion, pecking at and then swallowing the stones.

iv. **Bill wiping**: GIB rubs the sides of its bill along a stone or a boulder, removing any food attached to the bill. Bill wiping is seen more frequently during the rainy season as the bill is more often soiled with mud during this time. Bill wiping was never seen against the bark of a tree or bush.

v. **Defecation**: Faecal matter is excreted throughout the day. Birds defecate mainly while walking, pausing slightly as the faeces are egested.

6. ANTAGONISTIC BEHAVIOUR

Four types of antagonistic behaviours were recorded:

i. **Aggressive displacement**: Aggressive displacement involves one bird chasing the other. It starts with the aggressor stretching its neck, raising its crest, erecting the neck feathers, lifting its tail with a slight ruffling of body feathers, and running towards the other bird (Fig. 22). Both sexes show aggressive displacement. Aggressive displacement was often observed when birds congregate for feeding or drinking. Females do not chase adult males.

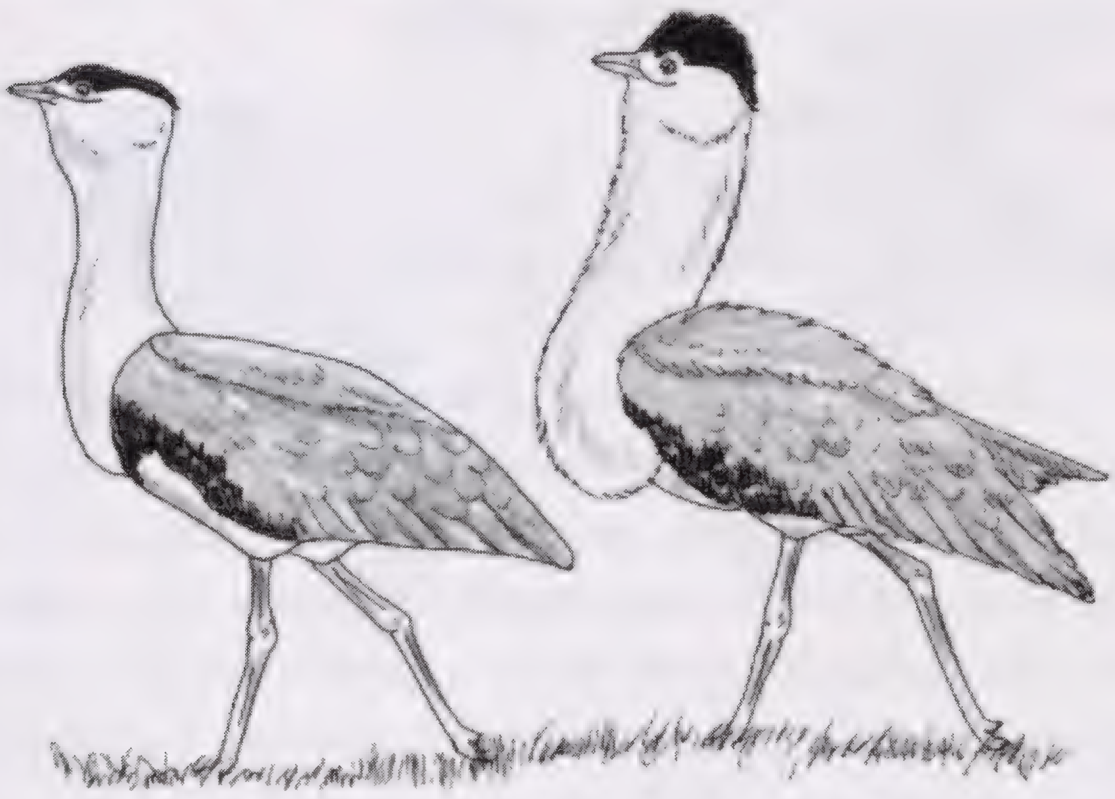

Fig. 22: Aggressive displacement

ii. **Non-aggressive displacement**: In non-aggressive displacement, a bird walks towards another, causing the second bird to leave its position and to move elsewhere.

iii. **Tail fanning**: The tail is lifted perpendicular to the back, the feathers are fanned out and the tail is lowered (Fig. 23). This may be repeated many times. It is performed while standing as well as sitting. Tail lifting is an alert reaction and may be accompanied by erection of the crest feathers (see Crest up). Females may tail-lift when approached by a male or a female. Tail fanning was never observed in adult males, when approached by a female.

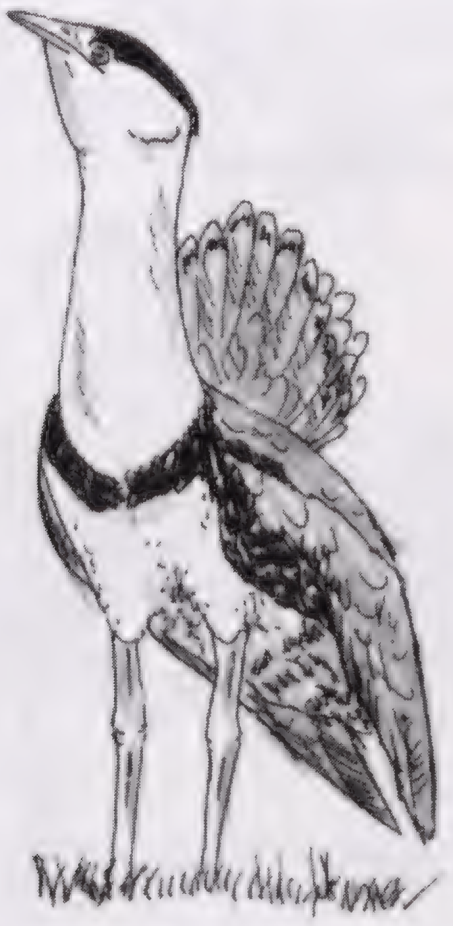

Fig. 23: Tail fanning

iv. **Tail cocking**: During tail cocking, the tail lies completely on the back. In adult individuals, the tail may touch the back of the neck. Tail cocking is seen only in males (Fig. 24). Isolated tail cocking is done during aggressive displacement, or as an alarm reaction to a perceived threat.

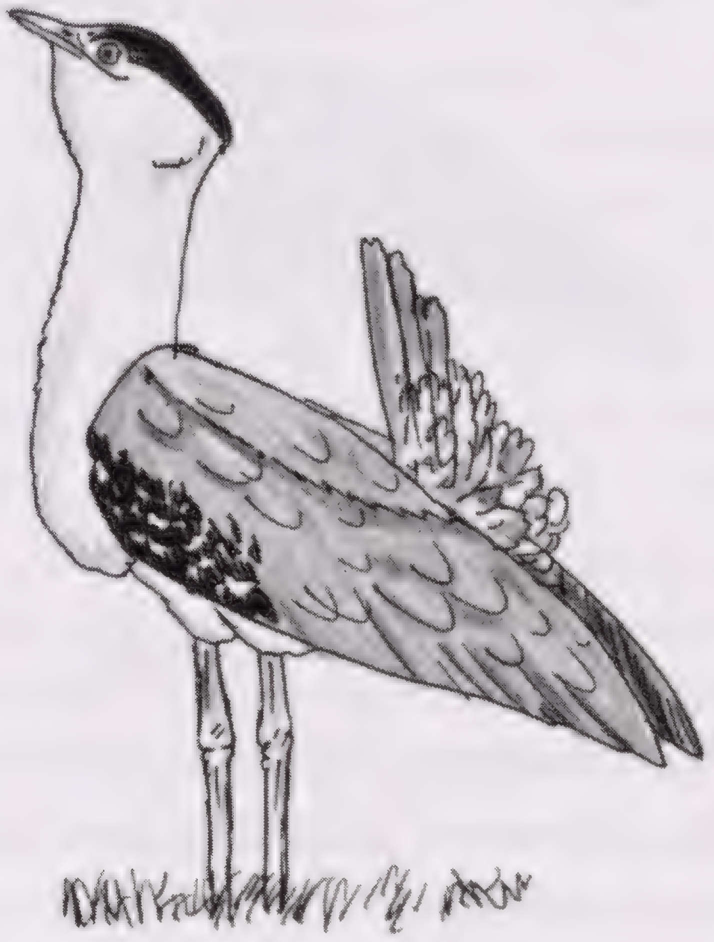

Fig. 24: Tail cocking

7. INTERSPECIFIC RESPONSE

Many species coexist in the same habitat as the GIB, and in its interaction with various species, the GIB shows fear of some, antagonism to others, and a neutral attitude to some (Rahmani and Manakadan 1987). GIB exhibits the following behaviours in response to perceived predation of self, egg, or young.

i. **Threat display**: Threat display is performed in a standing position with tail up and fanned, wings spread and outstretched, along with ruffled plumage and head extended forward or lowered. Simultaneous erection of crest feathers along with vigorous shaking of wings and tail may be seen (Fig. 25).

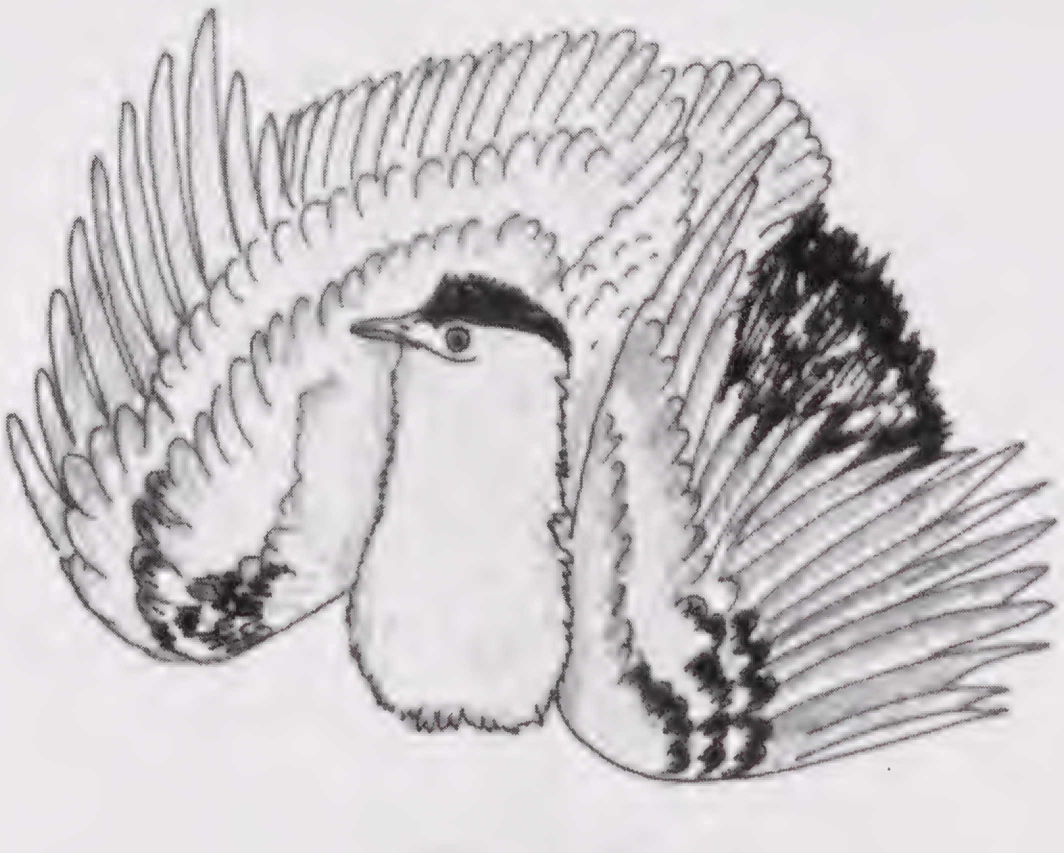

Fig. 25: Threat display

ii. **Skyward looking**: An alert bird extends its head upwards, and tilts the head sideways, thus only one eye faces skyward (Fig. 26).

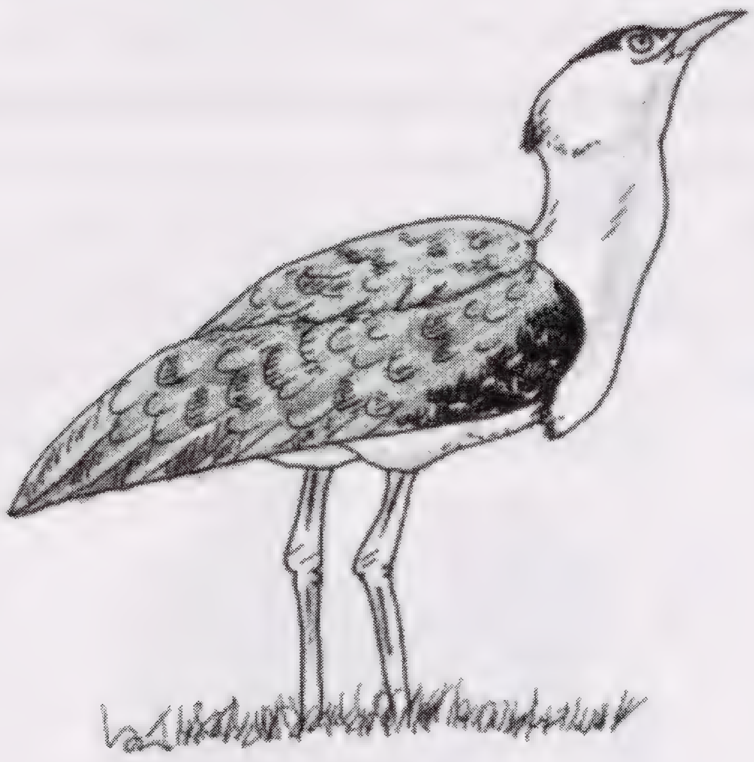

Fig. 26: Skyward looking

iii. **Crest erection**: The crest feathers of the head are erected as a response to a potential threat (Fig. 27). Crest erection is often preceded by neck fluffing.

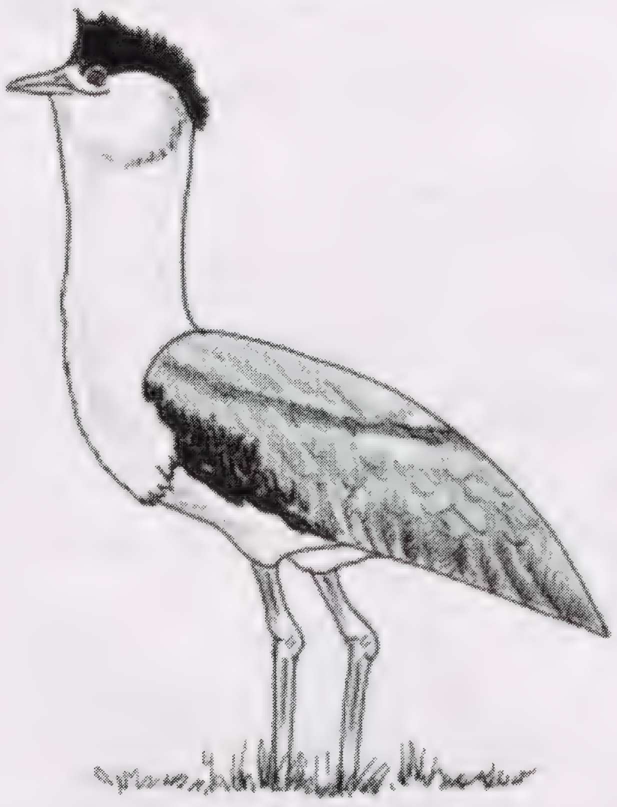

Fig. 27: Crest erection

iv. **Neck fluffing**: The neck and body are stretched vertically, the head is raised and the neck feathers are erected (Fig. 28). Neck fluffing is done in response to predators or other objects of concern. Neck fluffing can last for several minutes.

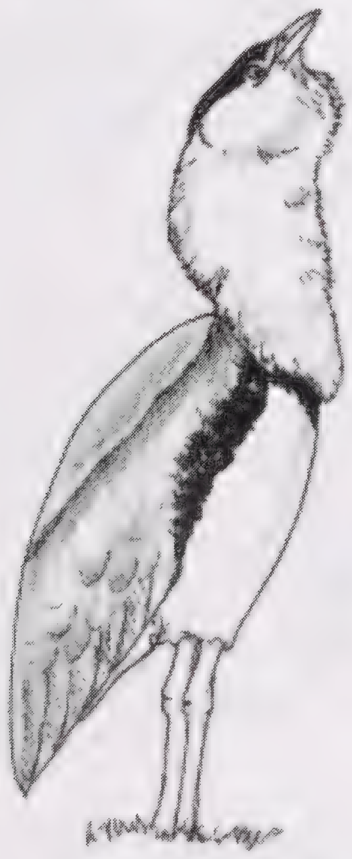

Fig. 28: Neck fluffing

v. **Freezing**: While sitting motionless on the ground, the neck is tucked against the back and the head is sunk between the shoulders (Fig. 29). Freezing is more commonly seen in juveniles and females.

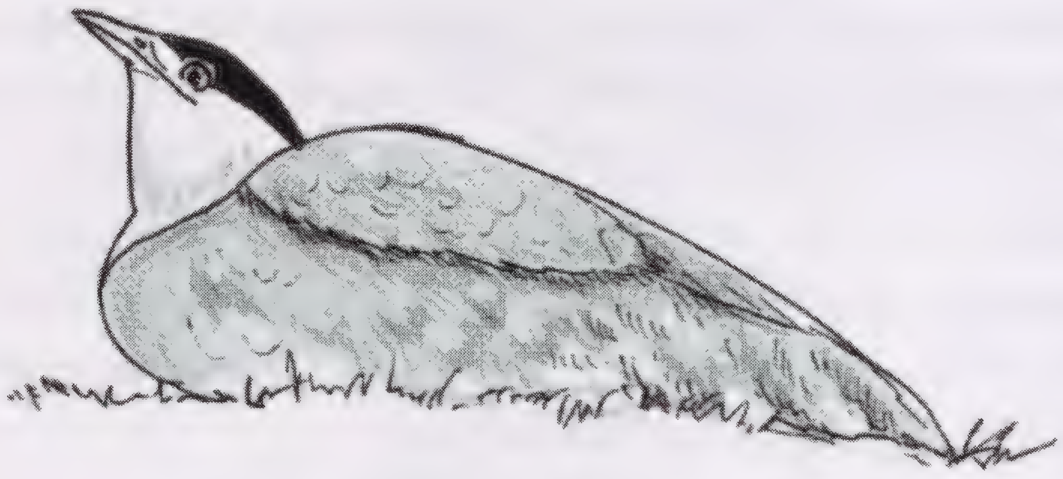

Fig. 29: Freezing

8. SEXUAL BEHAVIOUR

Sexual behaviour has been subdivided into male territorial, male courtship, and copulation behaviours.

i. **Male territorial behaviour**: During the breeding season, two adult males sometimes interact with each other at one of the bird's territory. Initially, the males perform what may be termed as the 'territorial march'. With tails fully cocked, gular pouch inflated, crown feathers erected, wings pointed downward, males aggressively walk parallel to each other with their inflated gular pouches swinging sideways (Fig. 30).

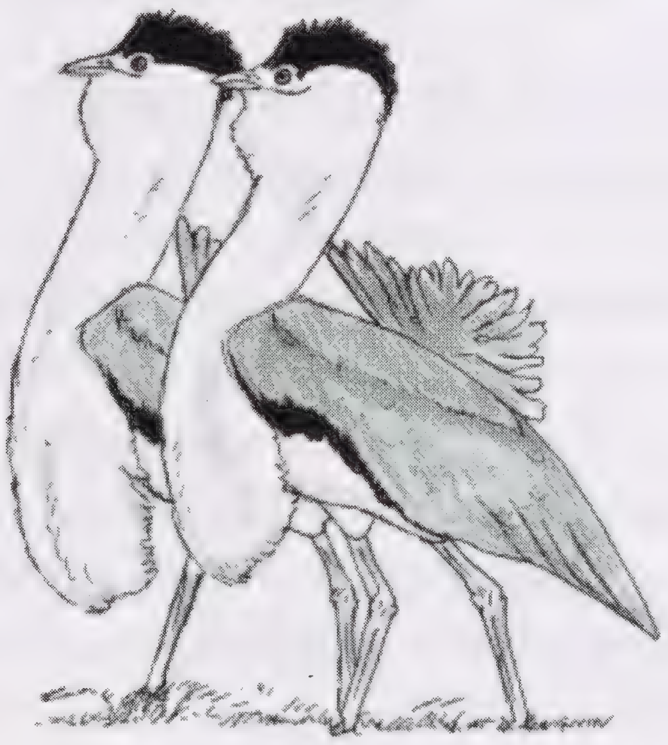

Fig. 30: Male territorial behaviour

Territory owner chases the intruder male in cocked up posture with erection of crest feathers (Fig. 31) what may be termed as the 'territorial chase'.

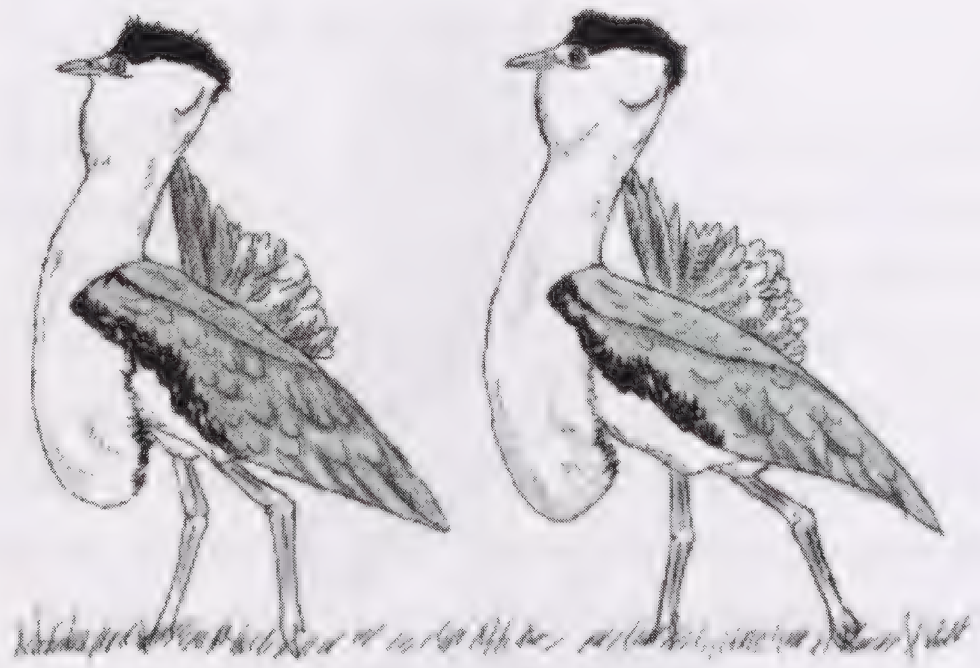

Fig. 31: Territorial chase

If the dispute is not resolved through the territorial march, a fight occurs. Fighting posture is similar to courtship display, with the addition of the erection of crest and crown feathers (Fig. 32a). While facing each other, both males simultaneously jump towards each other, bumping their chests and kicking at each other. Once they land, both hold onto each other by locking their necks and grasping beaks (Fig. 32b), and may peck at each other (Fig. 32c). Females have not been reported to engage in such physical combat.

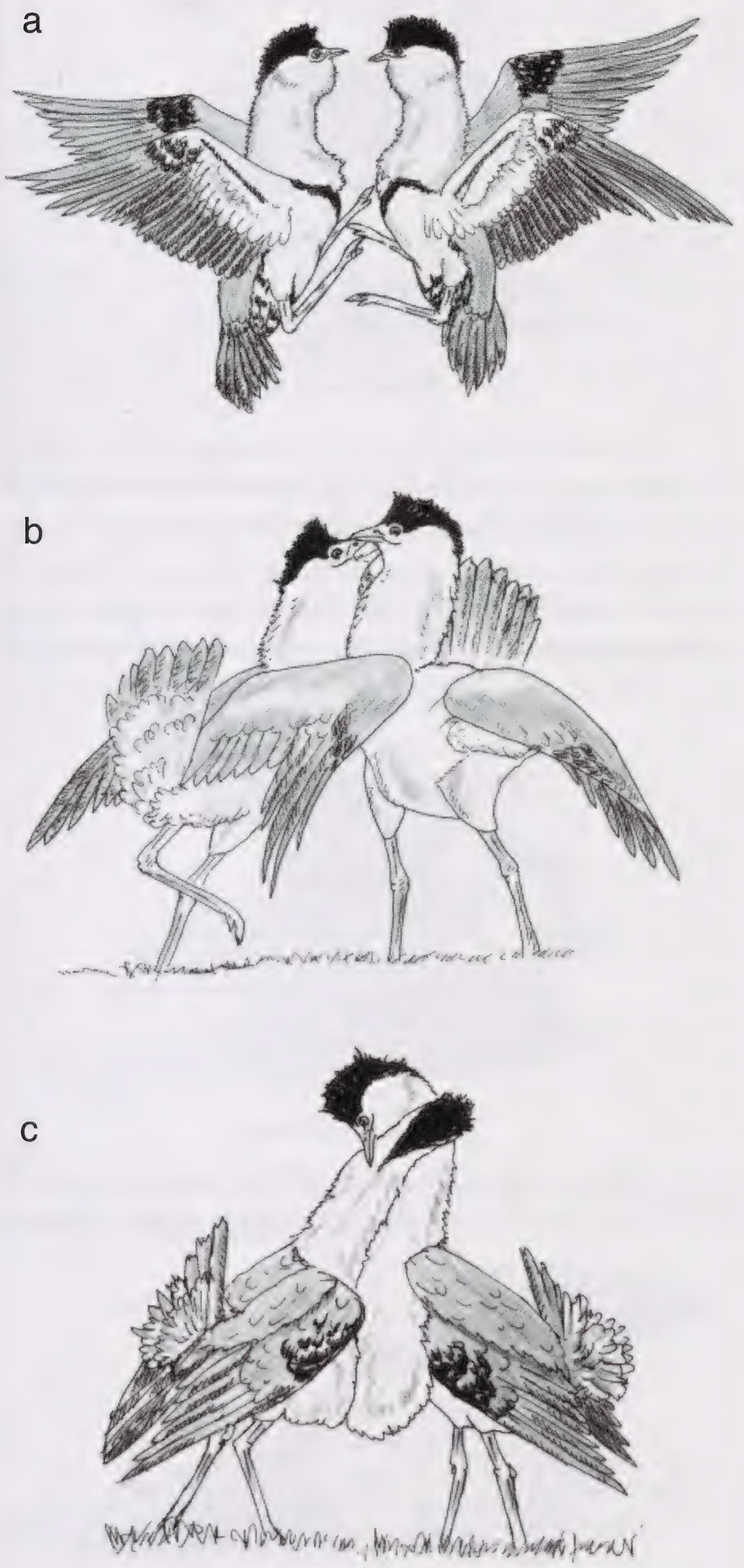

Fig. 32: Territorial fight

ii. **Male courtship behaviour**: Courtship display is performed to attract females and keep away rival males from a cock's territory. An adult cock selects a secluded but prominent area for display, and often uses traditional display areas. The female appears to be uninterested in displaying males and often deliberately avoids their advances, except when she is ready to mate. Male courtship behaviours consist of:

a. Complete courtship display: At the beginning of the display, the male holds its head high, stretching the neck vertically. Initially, it puffs its chin feathers. After repeatedly gulping air, the gular pouch starts inflating, becoming pendulous until it hangs like a balloon in front of the legs. Inflation of the gular pouch coincides with cocking of the tail (Fig. 33). In this complete courtship display posture, the male starts producing booming calls (see Vocalization) and turns in all directions to advertise itself. This helps to deliver visual as well auditory signals in all directions. If the hens are >100 m away, the male faces them, showing his white pouch. When a hen nears <10 m, the male turns his back towards her, revealing his cloaca by spreading out the feathers around the cloaca.

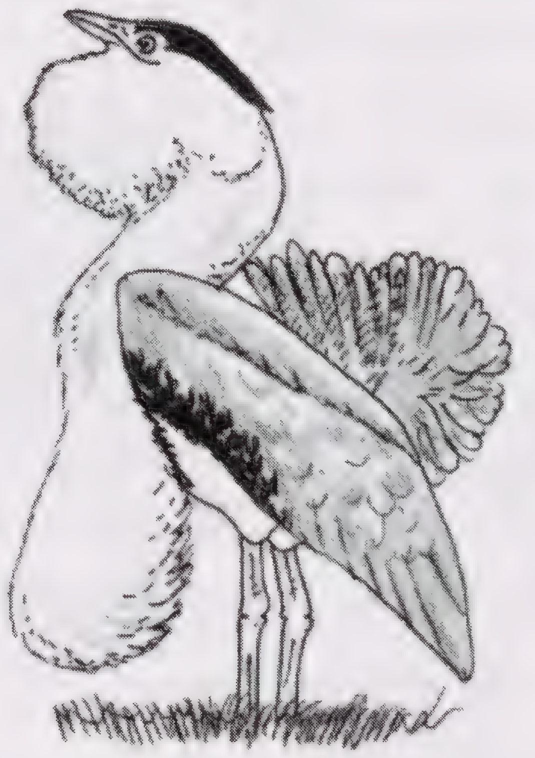

Fig. 33: Complete courtship display

b. Partial courtship display: During partial courtship display, the tail is cocked but the gular pouch is not inflated or may be slightly inflated (Fig. 34). This position precedes or follows a complete courtship display.

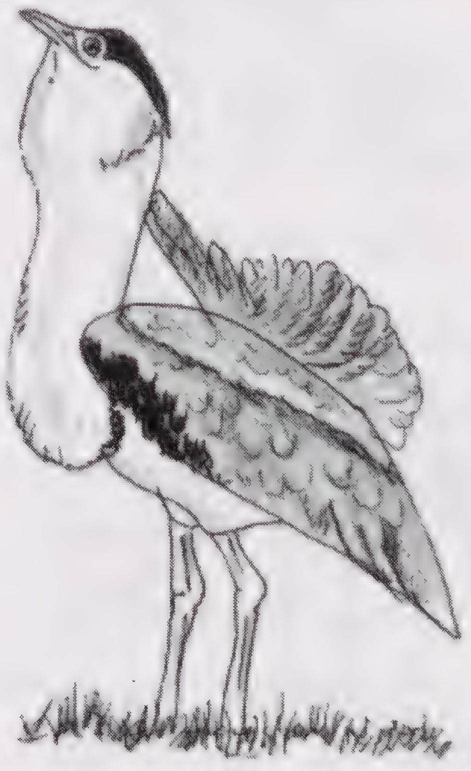

Fig. 34: Partial courtship display

c. Hanging pouch display: During the hanging pouch display, the gular pouch is fully inflated (sometimes touching the ground), but there is no cocking of the tail (Fig. 35).

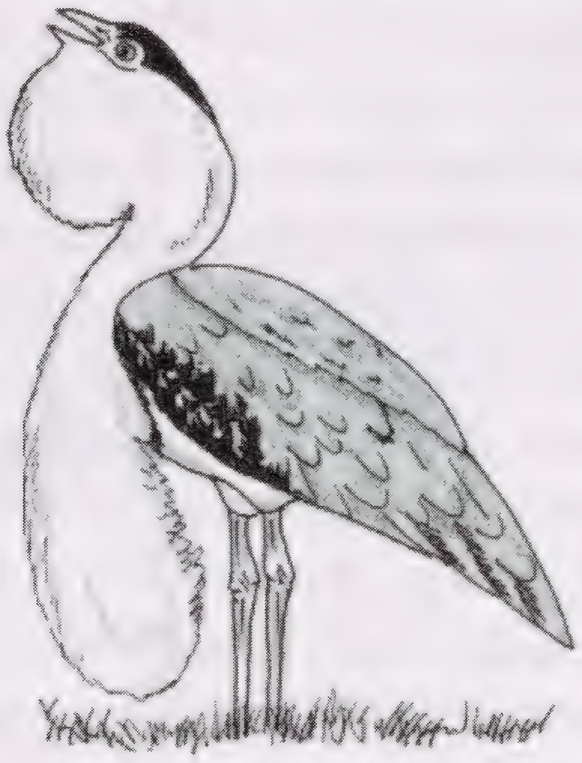

Fig. 35: Hanging pouch display

d. Female chasing: The male chases a female with erected crest and cocked tail. The gular pouch may or may not be hanging (Fig. 36). Unreceptive females show no interest and move away from the approaching male.

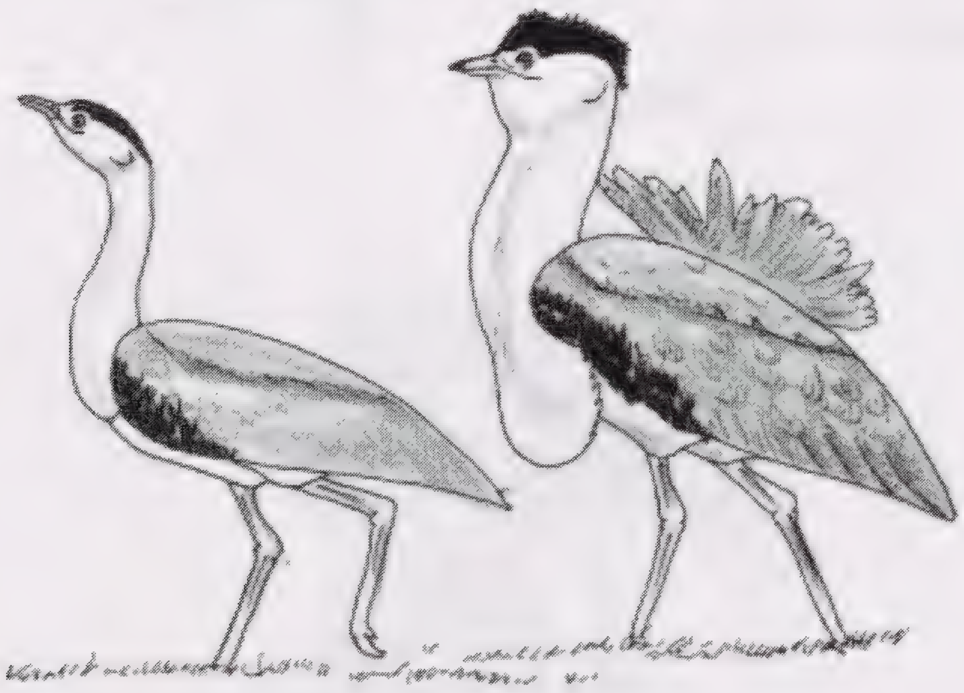

Fig. 36: Female chasing

e. Walking with inflated gular pouch: The male walks with gular pouch inflated and hanging in front without lifting the tail (Fig. 37). This posture is often seen intermittently between courtship display or when disturbed. If the male needs to fly, he deflates the pouch.

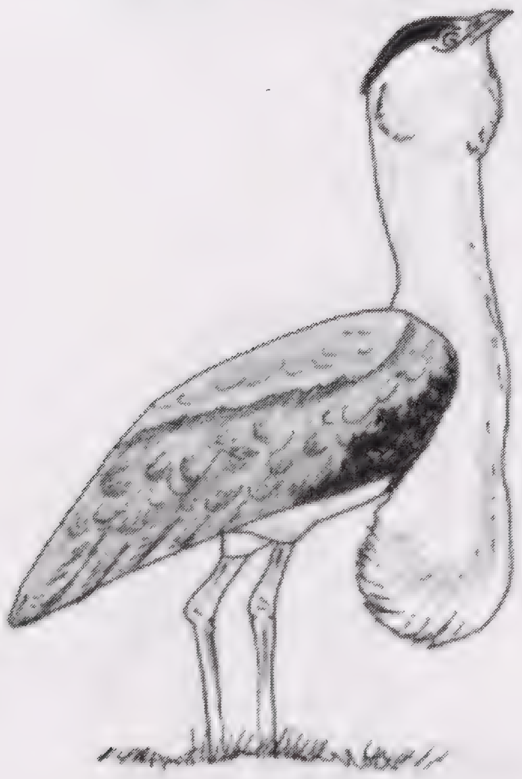

Fig. 37: Walking with inflated gular pouch

iii. **Copulation behaviour**: Copulation behaviour consists of the following phases:

a. Initiation to copulation: Copulation occurs with a receptive female during the peak courtship display, and on the display grounds. If the female is receptive, she sits down near the displaying male (Fig. 38), indicating that she is ready for mating.

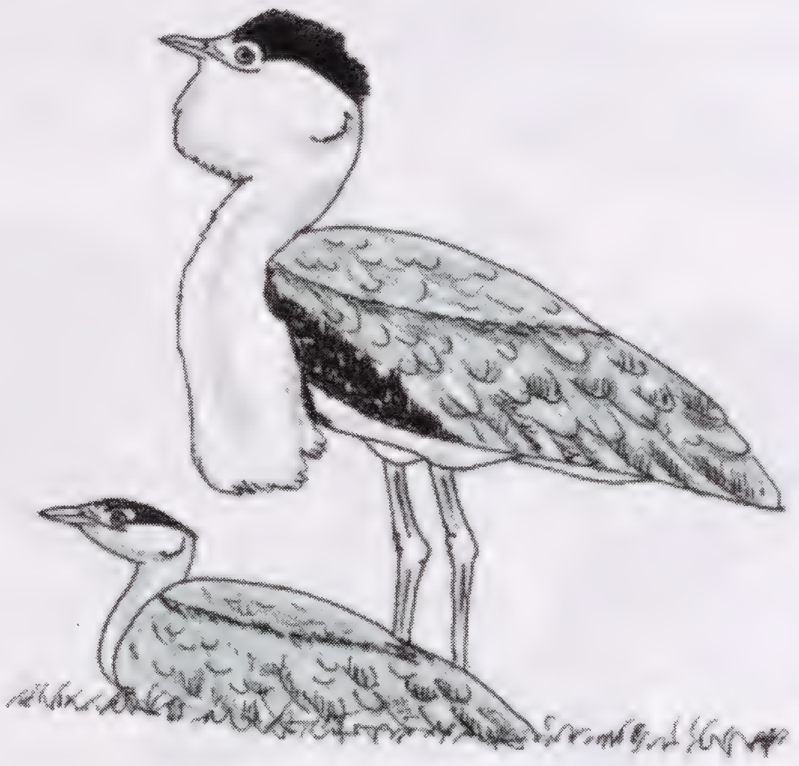

Fig. 38: Initiation to copulation

b. Head nibbling: Moving on both sides of the female, the male pecks at the back of the female's head (Fig. 39). This is repeated several times. The female remains seated throughout the entire bout of head pecking, recoiling each time the male pecks her. Nibbling can be rough, causing bleeding in some cases, and even death in captive birds in the case of the Australian Bustard *Ardeotis australis*.

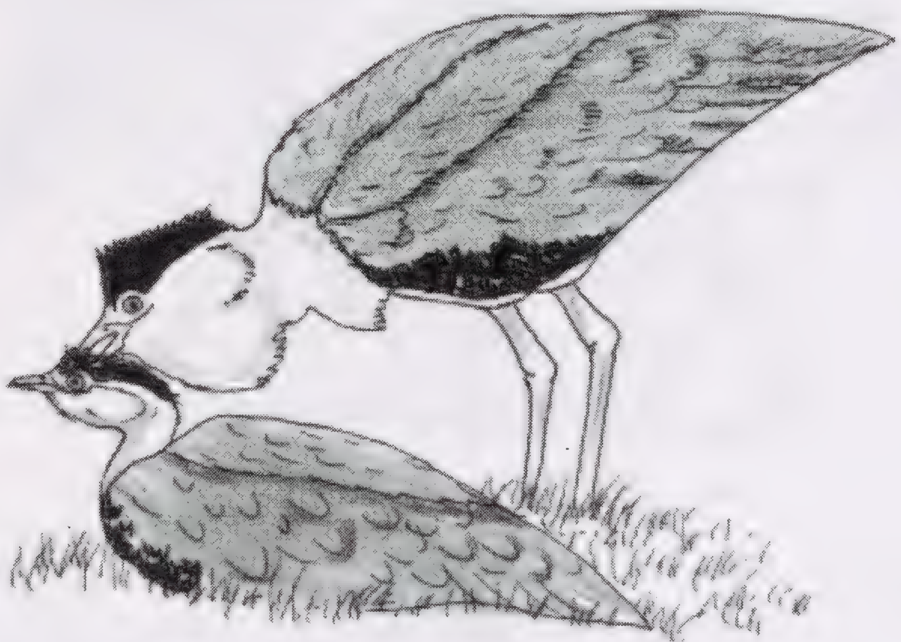

Fig. 39: Head nibbling

c. Bill clasping: The male grabs the female's beak with its bill (Fig. 40). This occurs intermittently during nibbling.

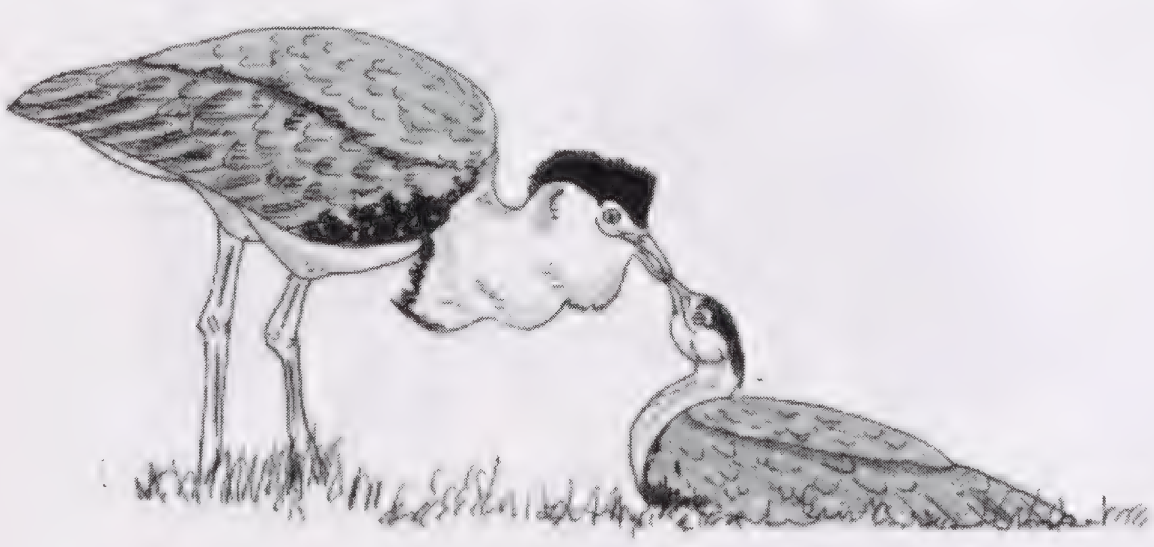

Fig. 40: Bill clasping

d. Mounting: The male mounts the female from behind, spreading his wings for balance while bringing his cloaca to the female's cloaca (Fig. 41) to copulate.

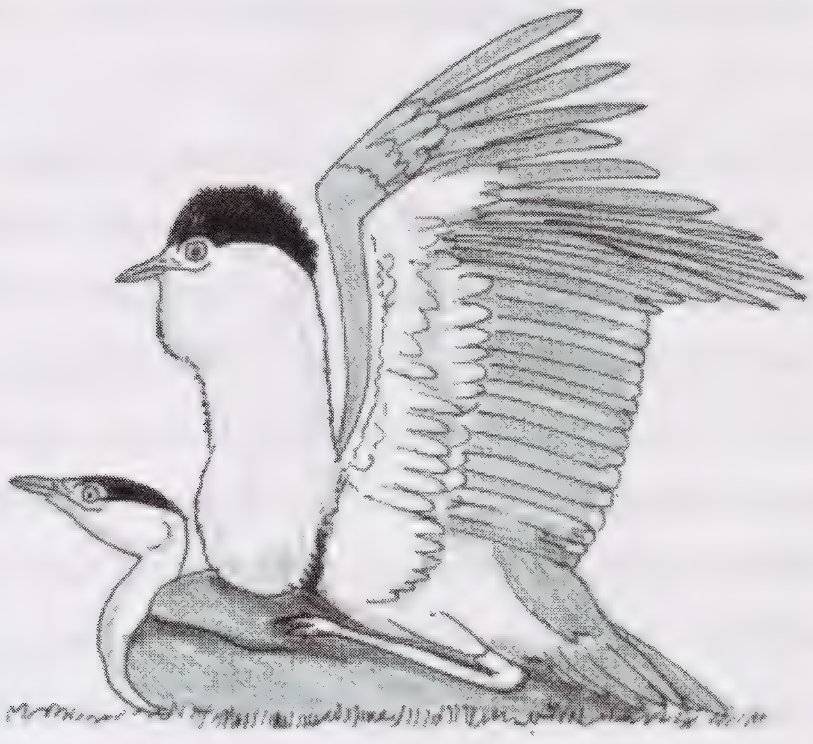

Fig. 41: Mounting

e. Post-copulation feather shaking: After copulation, the male dismounts. Both birds rise and vigorously shake their feathers. The female runs or walks briskly away from the male, while the male remains in his territory, and may start displaying again.

9. MATERNAL BEHAVIOUR

Maternal behaviour includes the following:

i. **Egg straddling**: Just before sitting for incubation, the female sits on her tarsi, and moves her body to adjust her position (Fig. 42).

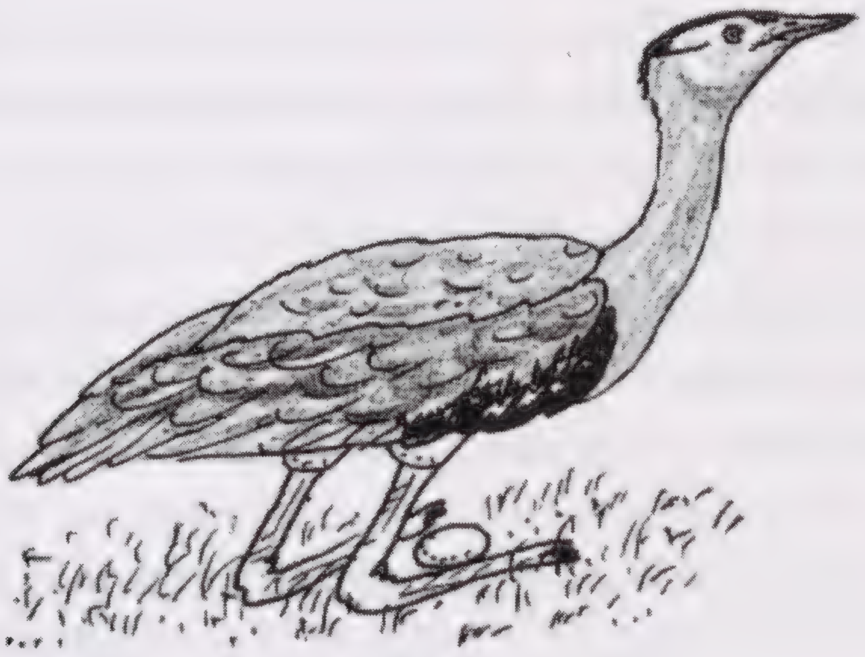

Fig. 42: Egg straddling

ii. **Incubation**: The posture commonly adopted by incubating females is shown in Fig. 43.

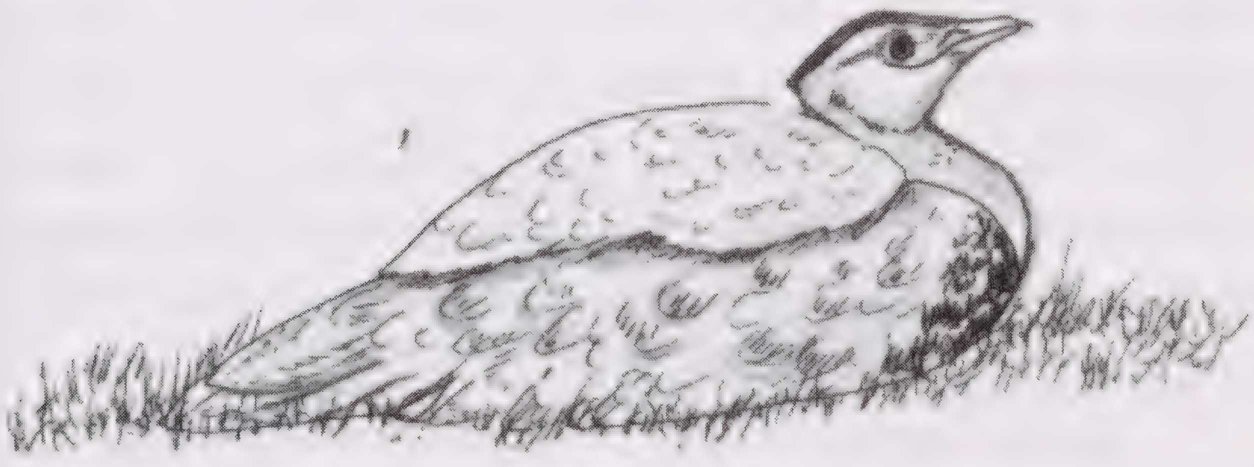

Fig. 43: Incubation

iii. **Egg turning**: While standing over the nest, the female rotates the egg with her bill several times throughout the day (Fig. 44).

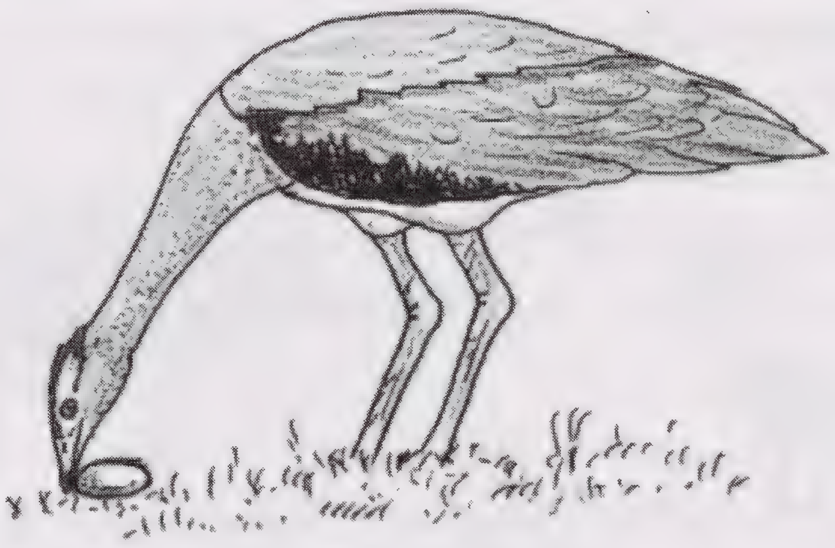

Fig. 44: Egg turning

iv. **Debris tossing**: While incubating, the female occasionally picks up small stones and throws them onto her back or from one place to other. Similar behaviour in Kori Bustard *Ardeotis kori* has been proposed as displacement behaviour for the absence of nest building activity or as a strategy to improve the female's camouflage and make her less visible to predators (Lichtenberg and Hallager 2006). Debris tossing could be displacement behaviour, arising out of boredom or on seeing some disturbance.

v. **Tarsal walking**: A nesting female moves towards the nest in hock-sitting position by walking on her tarsi. Tarsal walking is seen in incubating hens in response to a perceived threat or a predator at a close distance from the nest. It makes the female less conspicuous in the surroundings, in order to not reveal the nest location.

vi. **Distraction display**: A nesting female or female with a chick sometimes feigns injury by flying low with outstretched wings and dangling its legs as if wounded (Fig. 45).

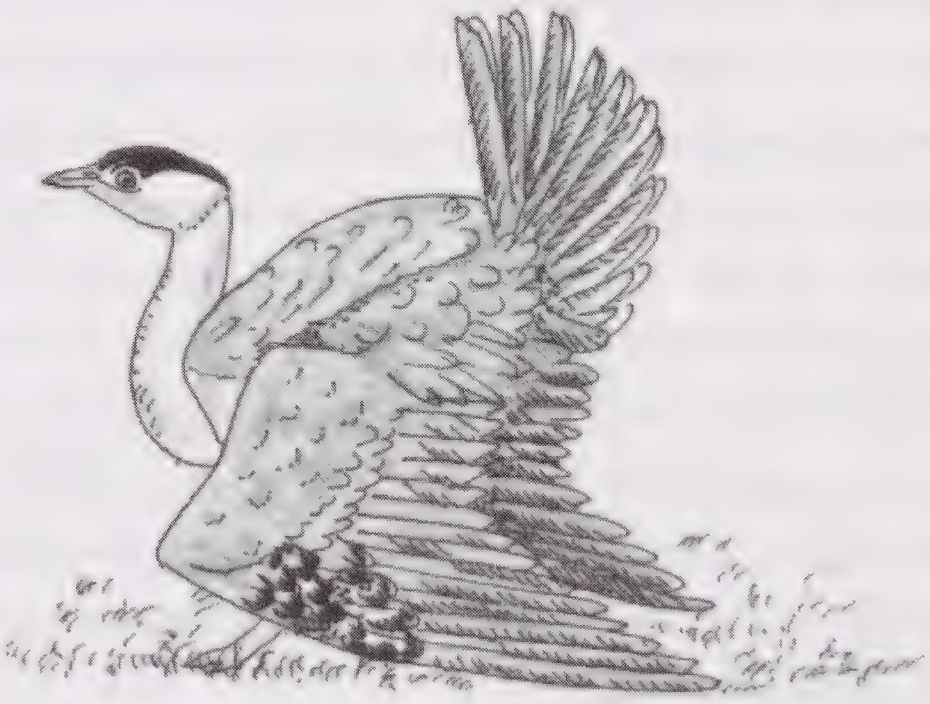

Fig. 45: Distraction display

vii. **Predator chasing and pecking attack**: Small to medium-sized predators of eggs and chicks, e.g., Indian Fox *Vulpes bengalensis*, Golden Jackal *Canis aureus*, House Crow *Corvus splendens*, and Monitor Lizard *Varanus bengalensis* that come close to the nest or juvenile are chased away by the female. The female uses her bill to strike at a perceived predator of her egg and chick. Females have been seen pecking at House Crow, Indian Fox, and Monitor Lizard (Rahmani 1989).

viii. **Bill to bill feeding**: The female picks up food and bending her head and neck down, presents it to the chick, while holding it in her bill (Fig. 46). Large insects are broken into a size suitable for feeding the chick.

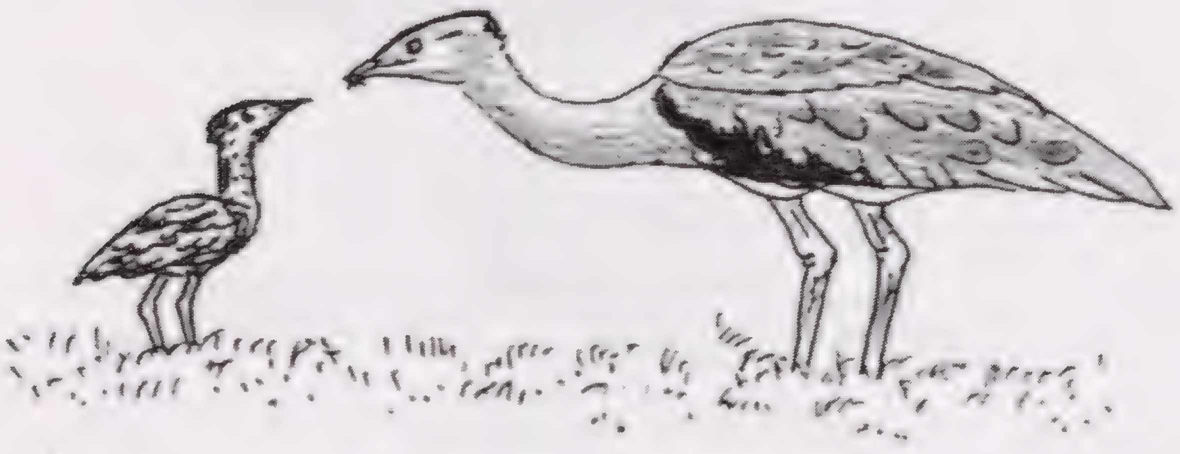

Fig. 46: Bill to bill feeding

10. VOCALIZATIONS

Adult GIB vocalizations include:

i. **Barking**: Barking calls are given by both sexes (Neginhal 1983; Vyas *et al.* 1983) and have been reported in incubating females (Neginhal 1983) and females with a chick. Barking serves as a form of communication, and is often done along with a threat display, probably as an alarm call.

ii. **Growling**: This vocalization consists of a soft *rrrrrr* sound, similar to a cat's growl. It is seen in response to a predator or perceived threat.

iii. **Male courtship vocalization**: During the courtship display, three distinct calls are produced in sequence by the male.

a. Chuck: During the initial states of inflation of the gular pouch, a low feeble clicking sound is produced when the bill is opened to gulp air.

b. Boom: Males emit a low-pitched booming call during the breeding season. It is produced only at peak display. The booming call can be heard up to a kilometre or more away, depending on the direction of wind (Rahmani 1989). The booming call is likely produced by the forcible ejection of air from the gular pouch, rather than from any syringeal apparatus, as in other large bustard species (Collar 1996). The frequency of booming calls was from 100–200 Hz, with an average duration of 0.9 sec, and an average pause of 14 sec between two calls.

c. Burr: A slow, long, murmuring call after the booming call, it is produced only after the initial 10–15 booming calls, and probably occurs when the air is expelled from the pouch (Rahmani 1989).

11. REFLEXES

i. **Sneezing**: This is as implied. Sneezing is a protective reflex against nasal irritation.

ii. **Coughing**: This is as implied. Coughing is a protective reflex against respiratory irritation.

DISCUSSION

This first published ethogram on the GIB provides an important foundation for further quantitative study of GIB behaviour. Behavioural research can directly contribute to various conservation programmes such as captive breeding (Angeloni *et al.* 2008; Curio 1996; Swaisgood 2010). Ethographic studies of juveniles can be used to assess health, growth patterns, and to predict chances of survival in the wild, as well as to assess different chick rearing practices (van Heezik and Seddon 1998). Captive rearing and documentation of the growth and behaviour of a GIB till about one year old was done by Manakadan and Rahmani (1996). This ethogram provides standard definitions of various common behaviours that could be valuable for captive breeding programmes of the GIB.

Various behavioural patterns are distinctly related with specific habitat needs, e.g., open short grass plains and open scrublands are preferred for nesting, display, foraging, and roosting (Rahmani 1989; Rahmani and Manakadan 1988). Hence, studying various behaviours with respect to habitat utilisation could be of importance for habitat management of GIB.

Comparison of behaviour of GIB with that of other species can emphasise traits potentially shared by specific groups of bustards. Many of the behaviours described for GIB are also reported for other bustard species. Resting behaviour appears similar in Kori Bustard *Ardeotis kori* (Lichtenberg and Hallager 2006), Houbara Bustard *Chlamydotis undulata* (Launay and Paillat 1990), Great Bustard *Otis tarda* (Hellmich 1987), and Australian Bustard *Ardeotis australis* (Ziembicki 2010). Dust bathing is seen in Kori Bustard (Lichtenberg and Hallager 2006), Houbara Bustard (Hinz and Heiss 1989), and Australian Bustard (Ziembicki 2009). Bill open behaviour is also seen in Kori Bustard (Lichtenberg and Hallager 2006). Drinking is similar in Kori Bustard (Lichtenberg and Hallager 2006), Australian Bustard (Fisher *et al.* 1972), and Buff-crested Bustard *Eupodotis ruficrista* (Hallager 1994). Head jerking behaviour which was seen in Houbara Bustard (Launay and Paillat 1990) and Kori Bustard (Lichtenberg and Hallager 2006) was not seen in GIB. Head jerking has been proposed to serve a social function for Houbara Bustard (Launay and Paillat 1990). Tail lifting has been seen in Little Bustard *Tetrax tetrax* (Schulz 1986), Houbara Bustard (Launay and Paillat 1990), and Kori Bustard (Lichtenberg and Hallager 2006).

Threat display is seen in Great Bustard (Hellmich 1987), Houbara Bustard (Launay and Paillat 1990), Kori

Bustard (Lichtenberg and Hallager 2006), and Australian Bustard (White 2012). Predator defence display is similar in Houbara Bustard (Launay and Paillat 1990), Kori Bustard (Lichtenberg and Hallager 2006), and Australian Bustard (White 2012). Debris tossing has also been observed in White-bellied Bustard *Eupodotis senegalensis*, Buff-crested Bustard and Houbara Bustard (F. Launay pers. comm.), and Kori Bustard (Lichtenberg and Hallager 2006). Tail up posture is seen in Great Bustard (Hidalgo de Trucios and Carranza 1991) and Kori Bustard (Lichtenberg and Hallager 2006).

Partial courtship display is also seen in Great Bustard (Hidalgo de Trucios and Carranza 1991) and Kori Bustard (Lichtenberg and Hallager 2006). Balloon display is seen in Great Bustard, Denham's Bustard *Neotis denhami* and Australian Bustard (Osborne 1984), and Kori Bustard (Lichtenberg and Hallager 2006). Booming call is seen in Australian Bustard (Ziembicki 2010) and Kori Bustard (Lichtenberg and Hallager 2006). Chasing females is seen in Little Bustard (Schulz 1986), Kori Bustard (Lichtenberg and Hallager 2006), and Australian Bustard (Ziembicki 2009).

Head nibbling is similar in Kori Bustard (Hallager 2003) and Australian Bustard (White 2012). Territorial march and territorial chase are reported in Australian Bustard (Ziembicki 2010). Skyward looking is reported in Kori Bustard (Lichtenberg and Hallager 2006). It has been suggested that it increases the field of vision and bustards in this posture are probably more attentive to their surroundings (Lichtenberg and Hallager 2006).

Maternal behaviours seen in GIB – predator chase, threat display, distraction display, and bill to bill feeding – are similar in Australian Bustard (White 2012; Ziembicki 2010). Freezing in response is seen in Australian Bustard (White 2012), and serves to camouflage the bird against a perceived threat.

The duration of the male courtship display increases in the presence of hens, in the peak breeding season, and in cloudy weather (Rahmani 1989). In GIB, the longest duration of continuous display was reported at 240 minutes (Rahmani 1989). Male courtship displays are variable among different bustard species. Larger bustard species such as Kori Bustard (Lichtenberg and Hallager 2006), Australian Bustard (Ziembicki 2010), and GIB (Rahmani 1989) have ground displays. Males of smaller species, such as Lesser Florican *Sypheotides indicus* (Ali and Ripley 1980), Little Bustard (Schulz 1986), and Black Korhaan *Eupodotis afraoides* (de Swardt 1992) perform aerial displays. According to Sankaran (1997), there is a direct correlation between body size and display type in bustards. Wingspread sunning is similar in Kori Bustard (Lichtenberg and Hallager 2006) and Houbara Bustard (Launay and Paillat 1990).

The categories of behaviour discussed in this paper are the ones most commonly exhibited by GIB in the wild. Additional detailed studies on age-specific behaviour and interspecific behaviour are needed. Better understanding of behaviour is the necessary first step towards improving the husbandry and management of future captive populations. Understanding GIB behaviour will also help in designing conservation strategies. Precise descriptions of behaviours and the ethograms presented here provide a standard that can be used for systematic and quantitative study of behaviour of this Critically Endangered species.

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BIRD RECORDS FROM TAWANG DISTRICT, ARUNACHAL PRADESH, INDIA

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Arunachal Pradesh is known for its rich biodiversity, including avifauna. However, some areas in Arunachal Pradesh still need to be surveyed to document its biodiversity and avian diversity. In order to document the avian diversity in high altitude areas, especially in the north-western region bordering Myanmar and southern China, I carried out surveys in Tawang district, an important eco-region selected for the proposed Biosphere Reserve, which has similarity in bird assemblages with those of neighbouring Bhutan and southern China. Studies were carried out in four phases from November 2007 to March 2012, with more than three surveys of 14 days durations covering 24 localities of Tawang district. The main aim of the surveys was to document the seasonal bird diversity of Zimmithang-Nelya, an Important Bird Area (IBA) in the Eastern Himalaya. The surveys recorded 113 species of birds, including 25 migrant species. Significant records include the Snow Partridge *Lerwa lerwa,* Eurasian Woodcock *Scolopax rusticola*, and Broad-billed Warbler *Tickellia hodgsoni.*

Key words: Arunachal Pradesh, bird surveys, endemics, Tawang district, IBA

INTRODUCTION

Arunachal Pradesh (26° 28'–29° 30' N; 91° 30'–97° 30' E) covers a geographical area of 83,743 sq. km. It is the largest of the seven states comprising the north-eastern region of India. It is flanked by China in the north and north-east (1,080 km) and separated by the McMahon Line; by Bhutan (9,160 km) in the west; by Myanmar (440 km) in the east; and by the Indian states of Assam and Nagaland in the south. Arunachal Pradesh, one of the world's toughest mountainous terrains (encompassing *c.* 83,500 of the state's 83,743 sq. km area), rises in mighty convulsions of ridges and spurs from the foothills across the north bank of the Brahmaputra, also known as Sri Lohit in ancient literature. The heights gained by the mountain peaks along the crestline from the extreme western end to the easternmost corner show great variation, ranging from 1,829 to 6,400 m. The main ridges and spurs of what has sometimes been described as the Sub-Himalayas fan out to the plains mostly in transverse directions, i.e., in the north-south direction, rather than parallel to each other, except possibly in the present West Kameng and Tawang districts, where the prominent ridges run more or less parallel to each other from west to east. Arunachal Pradesh is ranked second among the states and union territories in terms of area under forest cover (Ministry of Environment and Forests 2001). According to the Forest Survey of India (2003), the forest cover area is 68,019 sq. km, constituting 61.5% of the total geographical area of the state and 6.7% of India. The state has broadly six forest types: tropical wet evergreen (rain forest), subtropical broadleaf, subtropical conifer, temperate broadleaf, temperate conifer, and subalpine forests/alpine scrub. Small savanna grassland patches occur along the major rivers.

Recently, the State and Central governments have decided to create another Biosphere Reserve (Tsangyang Gyatso) in the western part of the State, particularly in the Tawang district. Tawang district is located at the north-west extremity of Arunachal Pradesh, encompassing an area of 2,172 sq. km, and is in the tri-junction of south-eastern Bhutan, southern China and northern Assam – all these three regions are known for their rich avian diversity. Elevations range from 1,714 to 6,280 m, and the inhabitants occupy lower altitudes, where they enjoy a cool temperate climate. The vegetation of Tawang district is primarily tropical evergreen, subtropical evergreen, temperate forest, subalpine fir vegetation, alpine vegetation, and secondary scrub. The secondary scrub vegetation is dominated by *Erythrina arborescens* and *Elaeagnus parvifolia*. Tawang district was a part of the large Balipara Frontier Tract of Assam along with the present day West Kameng, East Kameng, Upper Subansiri, Lower Subansiri, and Papum Pare districts of Arunachal Pradesh. Tawang district was carved out of West Kameng district, which adjoins it to the south, and Bhutan lies to the east. Zimmithang valley, which is part of Zimmithang-Nelya (27° 42' N; 92° 23' E) Important Bird Area of the Eastern Himalaya (Islam and Rahmani 2004), is also located in the district.

As a part of the Endemic Bird Areas (EBA) of the Eastern Himalaya identified by BirdLife International, the region boasts of a rich array of Restricted Range species. Arunachal Pradesh has five Critically Endangered species, namely Oriental White-backed Vulture *Gyps bengalensis*, Slender-billed Vulture *Gyps tenuirostris*, Long-billed Vulture *Gyps indicus*, White-bellied Heron *Ardea insignis*, and Bengal Florican *Houbaropsis bengalensis*, besides the Endangered White-winged Duck *Cairina scutulata*. Arunachal Pradesh is one of the topmost birding areas in the world. However, this region, especially the Tawang-Chu valley of western Arunachal Pradesh, still needs to be explored in order to document its faunal wealth (Kumar 2008).

A total of 215 bird species were recorded from eastern Arunachal Pradesh by Katti *et al*. (1992), largely from four protected areas. According to Choudhury (2006), more than 700 species of birds are reported from Arunachal. It is one of the few areas in India where new avian species may still be discovered. For instance, in 1998, a new taxon of monal pheasant (*Lophophorus* sp.) was discovered (Kumar and Singh 2004) from western Arunachal Pradesh. In 2006, Athreya (2006) described a new species *Liocichla bugunorum*, family Timaliidae, from Eaglenest Wildlife Sanctuary. Kumar (2008) recorded 81 species of birds from Tawang district, including the Rusty-tailed Flycatcher *Muscicapa ruficauda*, probably a new record for the state. Sangha and Naoroji (2007) conducted surveys in Tawang district in December 2005 and obtained many significant records.

Faunal surveys are being undertaken throughout Arunachal Pradesh as part of Zoological Survey of India's (ZSI) Annual Research Plan funded by the Ministry of Environment & Forests, Government of India. As a part of these surveys, I surveyed the birds of Tawang district, especially the Important Bird Area of Zimmithang-Nelya. As the study area is adjacent to south and south-eastern Bhutan and southern China, the sightings were compared with bird records in the literature from these regions (Ali *et al*. 1996; Ludlow 1937; Ludlow and Kinnear 1944; Shing *et al*. 2006). The special reference on the birds of Bhutan was Ali *et al*. (1996), which was based on surveys/collections of birds between February 1966 and December 1973. The reference on the birds of southern China was Shing *et al*. (2006) who conducted rapid biodiversity surveys in 54 forest areas in the provinces of Guangdong, Guangxi, and Hainan and recorded 372 species of birds between 1997 and 2004.

METHODS

The surveys were mostly carried out between November 2007 and March 2012 in the Tawang-Chu valley, especially around Tawang, Lumla, and Zimmithang, besides the other areas mentioned in Appendix 1. Four surveys covering all the seasons were carried out, an average of 14 days being spent on each survey. The areas surveyed varied in altitude from 1,194 m (Thonglanlong) to 4,328 m (Klemthang). Observations were made using 10 x 50 binoculars, and efforts were made to photograph all the species encountered. Field trips were conducted during early mornings immediately after the onset of daylight, which is much earlier in the north-eastern states than in the rest of India. Observations were usually terminated at around 08:30 hrs and resumed after 15:00 hrs, to continue till dusk. The areas and the distances covered in each locality varied, but each site was surveyed twice to record birds in the morning and evening. The bird nomenclature used in this paper follows Rasmussen and Anderton (2012).

RESULTS

A total of 113 bird species were recorded during the surveys of Tawang district (Appendix 1). The majority of the species recorded were insectivores, followed by some raptors. Few frugivores were recorded, obviously due to the scarcity of fruiting trees at these relatively high altitudes. Discussed below are some significant records. Some bird species common to Arunachal Pradesh also figure in the discussion, as little literature is available on their distribution and population in western Arunachal Pradesh.

Indian Spotted Eagle *Clanga hastata*

On October 13, 2009, an individual was seen soaring near Zimmithang Tourist Lodge. The Indian Spotted Eagle has been reported as common in the woodlands of Kaziranga National Park (Barua and Sharma 1999). The last nest recorded was in Keoladeo National Park, Bharatpur, in 1986. Prior to that, there were only three records of nesting more than 80 years ago. However, it is now believed to have a separate population in Karnataka, Tamil Nadu, and Andhra Pradesh; recent reports with photographic evidence have come from other states, namely Gujarat, Maharashtra, and West Bengal (Rahmani 2012).

Mountain Hawk-Eagle *Nisaetus nipalensis*

On October 9, 2009, one bird was recorded near Zimmithang. Singh (1994) had recorded the species in Seijosa (Pakke Tiger Reserve), Arunachal Pradesh. According to Ali *et al*. (1996), several hawk-eagles, either Mountain or Crested Hawk-Eagle (*Spizaetus cirrhatus*) were recorded on several occasions in Bhutan, especially at Mangdechu, Babase, and Gedu in 1967 and 1968. It has also been recorded in Eaglenest and Sessa Orchid Wildlife Sanctuaries of Arunachal Pradesh at *c*. 2,700 m (Choudhury 2003). The species is recorded occasionally as a migrant in Kaziranga National Park, Assam, mostly in woodlands (Barua and Sharma 1999), and is rare or occasional in secondary forests of Nameri National Park, Assam (Barua and Sharma 2005). It was listed as rare in northern Myanmar during ornithological expeditions in 1998 and 1999, mostly at *c.* 980–2,400 m (King *et al.* 2001). It was recorded in 11 different localities in southern China by Shing *et al.* (2006).

'Steppe' Buzzard *Buteo buteo*

I sighted two birds soaring over a big patch of disturbed shrub forest opposite the Lumla Circuit House during February 2009. Singh (1994) recorded the species at Hotspring and at Talley valley from *c.* 2,500–3,600 m. Ali *et al.* (1996) had recorded the species, mostly singly on bare branches of trees, and collected specimens at Rongthung (*c.* 1,740 m), Kanglung, Balfai, and Gomchu in eastern Bhutan in March 1966 and April 1973. In Kaziranga National Park, Assam, it was recorded in deciduous and woodland forests, mostly as a migrant. It was reported as uncommon in northern Myanmar from 850–2,900 m during ornithological expeditions in 1999 by King *et al.* (2001).

Upland Buzzard *Buteo hemilasius*

On October 6, 2009, on the way to Bumla, I saw a bird perched on an electric pole near Klemtang (27° 41' 08.2" N; 91° 52' 21.4" E) at 4,328 m in alpine scrub forest. The Upland Buzzard is a winter visitor to the Himalaya, with confirmed (specimen) records only from E. Kashmir, Nepal, Sikkim, and Darjeeling, and sight records from Himachal Pradesh, Punjab, and Delhi (Rasmussen and Anderton 2012). This is the first record for the species in Arunachal Pradesh.

Oriental Honey-Buzzard *Pernis ptilorhynchus*

On October 10, 2009, on the way to Y-Junction from Zimmithang, I recorded an Oriental Honey-Buzzard soaring above a patch of evergreen forest. Singh (1994) had recorded the species at Khari (Pakke Tiger Reserve) in Arunachal Pradesh. Ali *et al.* (1996) sighted a single bird at Gaylegphug (*c.* 250 m) on April 27, 1967, in Bhutan. It has been recorded as common and resident in Kaziranga National Park, Assam, by Barua and Sharma (1999), inhabiting grasslands and woodlands. Barua and Sharma (2005) had recorded it in Nameri National Park, Assam, as a common and widespread resident in secondary forest, grasslands, and deciduous forests. It was recorded as rare and uncommon in northern Myanmar by King *et al.* (2001) during ornithological surveys in 1999. It was recorded in seven different sites in southern China mostly in Guangxi province (Shing *et al.* 2006).

Himalayan Vulture *Gyps himalayensis*

Two birds were sighted flying near Ptiso lake near Tawang on October 6, 2009. Singh (1994) had recorded the Himalayan Griffon at Thingbu (*c.* 3,300 m). Ali *et al.* (1996) recorded a bird soaring over a ridge at *c.* 2,896 m above Kha Ling in eastern Bhutan in March 1966. It has been recorded above *c.* 2,800 m in Eaglenest and Sessa Orchid Wildlife Sanctuaries, Arunachal Pradesh (Choudhury 2003). It is listed as an uncommon migrant in Kaziranga National Park, Assam (Barua and Sharma 1999) and Nagaland (Choudhury 2001).

Snow Partridge *Lerwa lerwa*

A flock of Snow Partridge (8–10 birds) was recorded on the route (3,342 m; 27° 29' 5.7" N; 92° 06' 29.4" E) to Sela Top (3,914 m) from Dirang on February 22, 2009. No snowfall had occurred at that time in most of Tawang (except Sela Top area) in 2009. However, the next day (February 23, 2009), belated snowfall started in the entire region and continued for more than 10 days. From this, it appears that the partridges spend their summer at much lower elevations, and as the snowfall occurs, they start ascending the mountains. The area used by the birds before the onset of snowfall in such lower altitudes needs to be ascertained. The only protected area from where the species has been reported from Arunachal Pradesh is Dibang Wildlife Sanctuary; however, its status is uncertain (Choudhury 2006). Singh (1994) had not recorded it in Tawang district, but from Tipi and also once from Mehao Wildlife Sanctuary in Upper Siang district of Arunachal Pradesh. Ali *et al.* (1996) mentioned it as 'scarce' in Bhutan and collected one specimen from Juitang (*c.* 4,300 m) in central Bhutan in October 23, 1973. Ludlow (1937) found it common on Me La (*c.* 4,572 m) in eastern Bhutan, from where he collected four specimens.

Common Hill-Partridge *Arborophila torqueola*

On October 9, 2009, around 10:00 hrs, I saw two partridges, probably a male and a female on a secluded road (27° 41' 33.2" N; 91° 43' 18.1" E) going to Y-Junction from Zimmithang. This area was a thick evergreen forest patch with a valley on one side and high mountain on the other. Choudhury (2003) had observed a bird on December 12, 1999, near Lama Camp of Eaglenest Wildlife Sanctuary, Arunachal Pradesh at *c.* 2,500 m. Singh (1994) recorded the species from Chakoo road, Talley valley, and Mayodia in Arunachal Pradesh, from *c.* 2,000–2,800 m. Ali *et al.* (1996) mentioned it as 'not uncommon' in Bhutan, but very shy and seen in coveys of three to six birds in dense undergrowth. Ludlow (1937) had often seen, and more often heard it, at various places in eastern Bhutan, especially Yonpu La (*c.* 1,829–3,048 m) during July, September, and November.

Eurasian Woodcock *Scolopax rusticola*

On October 10, 2009, I recorded an individual in a primary wet evergreen forest patch on the way to Y-Junction from Zimmithang. Singh (1994) recorded the species only at Orak (*c.* 1,100 m) in Arunachal Pradesh. According to Ali *et al.* (1996), a bird was caught on March 5, 1969, while foraging in a small swampy glade at Gedu (*c.* 1,829 m) in western Bhutan. Ludlow (1937) found a nest with four eggs at Sharithang in west Bhutan; there are no reported sightings of the species from eastern Bhutan. In Nagaland, it was recorded by Godwin-Austen in 1876 as a winter visitor. Also recorded in Nameri National Park of Assam as a rare winter visitor and mostly observed in Assam between December and April (Barua and Sharma 2005). It was reported from two localities in southern China by Shing *et al.* (2006) during their ornithological expedition.

Ashy-headed Green-Pigeon *Treron phayrei*

I had seen a flock of 8–10 birds once *c.* 7 km from Lumla on Zimmithang road on October 3, 2009. It is probably rare at such heights due to the lack of fruiting trees. Singh (1994) recorded it only at Khari (Pakke Tiger Reserve), Arunachal Pradesh. It is reported at *c.* 2,700 m elevation in Eaglenest and Sessa Orchid Wildlife Sanctuaries, Arunachal Pradesh (Choudhury 2003). Since it is a local migrant, it has been recorded occasionally in woodlands of Kaziranga National Park (Barua and Sharma 1999). Barua and Sharma (2005) reported that it was rarely recorded from November to March in Nameri National Park, though it is a resident species in the Park. It is also reported from Mouling National Park, Arunachal Pradesh, and Palak lake in south-west Mizoram (Birand and Pawar 2004).

Wedge-tailed Green-Pigeon *Treron sphenurus*

I recorded the Wedge-tailed Green-Pigeon on many occasions between Nelya and Zimmithang areas, especially in a primary broadleaf forest. Singh (1994) recorded it from Talley valley and Jengging area of Arunachal Pradesh. According to Ali *et al.* (1996), it was fairly common and recorded in flocks of about 12 to 20 birds in suitable patches of forest from *c.* 610–2,100 m throughout Bhutan. Ludlow (1937) found it fairly plentiful in eastern Bhutan. It is also reported below 1,800 m in Eaglenest and Sessa Orchid Wildlife Sanctuaries, Arunachal Pradesh (Choudhury 2003). It is an uncommon resident species in Kaziranga National Park, Assam, in secondary and woodland forests (Barua and Sharma 1999), and is 'locally common' in Nagaland (Choudhury 2001). According to Barua and Sharma (2005), it is a rare species, probably a winter visitor, to Nameri National Park, Assam. In Meghalaya, it has been recorded only from Balpakram National Park in the Garo Hills (Birand and Pawar 2004). It was listed as uncommon in northern Myanmar at 800–1,135 m during an ornithological expedition by King *et al.* (2001). The species was not recorded in southern China by Shing *et al.* (2006).

Asian Barred Owlet *Glaucidium cuculoides*

I recorded only one individual at Loudung village between Sherbang and Zimmithang around 12:30 hrs on October 4, 2009. Singh (1994) recorded it at Upper Dikroi, Itanagar, Yachuli, and Deban in Arunachal Pradesh. Ali *et al.* (1996) mentioned that Holmes found it to be fairly common in West Bhutan, and also in East Bhutan, especially at Rongthung (*c.* 1,830 m) during March 1966. According to Abdulali (1972), Bhutan appears to be the meeting ground of *cuculoides*, *rufescens*, *austerum*, and *whitely* races of the species. It was recorded by Allen (2002) from Dibru-Saikhowa Biosphere Reserve, Assam. There are also a few sightings from Eaglenest and Sessa Orchid WLS, Arunachal Pradesh, but below 2,500 m (Choudhury 2003). Recorded as common from various habitats inside Kaziranga National Park (Barua and Sharma 1999), it is one of the most common owlets in nine protected areas of north-east India (Birand and Pawar 2004). It is reported to be an uncommon, resident species in northern Myanmar below 1,200 m (King *et al.* 2001).

Golden-throated Barbet *Megalaima franklinii*

My only record of the Golden-throated Barbet was along the roadside near Zimmithang on October 13, 2009. Singh (1994) had recorded it at Chakoo road, Limeking, Sessa, and Ramsingh areas of Arunachal Pradesh. Ali *et al.* (1996) recorded it commonly in small feeding parties of 6–8 birds in eastern Bhutan, especially Gomchu (*c.* 2,286 m) and Langsaran (*c.* 1,250 m). It has been recorded in Eaglenest and Sessa Orchid WLS, Arunachal Pradesh, at *c.* 1,800 m, and in Nagaland as a common resident (Choudhury 2001). However, Birand and Pawar (2004) did not record it during their extensive surveys in north-east India in 2001 and 2002. King *et al.* (2001) found it 'uncommon' at *c.* 980–2,000 m during their expedition in North Myanmar in 1998 and 1999. It is reported in four different localities in southern China (Shing *et al.* 2006).

Grey-faced Woodpecker *Picus canus*

On February 26, 2009, I recorded a male Grey-faced Woodpecker gleaning food material on the floor of the secondary forest between Lumla and Shakti in Tawang district. Singh (1994) had recorded it at Khellong, Khari, Itanagar, and a few other sites in Arunachal Pradesh, mostly from 150–1,500 m. Ali *et al.* (1996) mentioned that it is common in pairs in forests between the foothills and up to

2,286 m, especially from Rongthung, Kanglung, and Gomchu areas of eastern Bhutan. Choudhury (2003) recorded it at Eaglenest WLS, Arunachal Pradesh, below 1,900 m. Barua and Sharma (1999) recorded it as a common species in secondary forests in Kaziranga National Park. Choudhury (2001) also recorded it in Nagaland during his surveys in 1990s. Barua and Sharma (2005) saw it sometimes in association with Greater Necklaced Laughingthrush (*Garrulax pectoralis*) and Lesser Necklaced Laughingthrush (*Leucodioptron monileger*) in Nameri National Park. It has also been recorded in Namdapha Tiger Reserve (Arunachal Pradesh), and in Balpakram National Park and Barail Reserve Forest in Mizoram (Birand and Pawar 2004).

Bay Woodpecker *Blythipicus pyrrhotis*

A lone bird was observed on October 3, 2009, between Lumla and Zimmithang. Singh (1994) had recorded the Bay Woodpecker from Pange and Deban-Hornbill of Namdapha Tiger Reserve, mostly from 160–1,500 m in Arunachal Pradesh. Ali *et al.* (1996) occasionally recorded pairs in forests from 380–2,240 m in Gomchu area of eastern Bhutan. It has also been recorded in Eaglenest and Sessa Orchid WLS of Arunachal Pradesh from *c.* 350–2,400 m (Choudhury 2003). It is resident in Kaziranga National Park, sighted occasionally and mostly in secondary forests (Barua and Sharma 2005). It has also been reported in northern Myanmar (King *et al.* 2001) and in 22 sites in three provinces (Guangdong, Guangxi, and Hainan) of southern China (Shing *et al.* 2006).

Rufous-breasted Accentor *Prunella strophiata*

On February 26, 2009, I recorded two individuals on the roadside between Lumla and Bomdir foraging on a grassy slope; this was the only record for the species during the surveys. Singh (1994) found it to be common in Tenga-Bomdi La road, Chiri La (Sela Pass in Tawang district), and Talley valley from 1,850–3,800 m. Ali *et al.* (1996) saw it frequently in pairs or small parties in bushes, fallow fields, and scrub. Ludlow (1937) reported it to be common in summer, especially in Rongthung, Gomchu, Wamrong, and Narphung in eastern Bhutan during February and March, 1966. Choudhury (2003) recorded it from Eaglenest and Sessa Orchid WLS, Arunachal Pradesh, from *c.* 2,500–2,800 m.

Alpine Accentor *Prunella collaris*

On March 3, 2009, I recorded two individuals along with Russet Sparrow *Passer rutilans* near Lumla Circuit House. Singh (1994) had recorded it only from Mayodia (near Sange) at *c.* 2,400 m, but could not ascertain its abundance there. Ludlow (1937) found it to be common at high altitudes, collecting one each at *c.* 4,572 m at Me La and Kang La in eastern Bhutan.

Long-billed Ground-Thrush *Zoothera monticola*

On October 2, 2009, while returning from Loudung village, I recorded and photographed two birds foraging on a roadside stream in a moist forest patch, which is the typical habitat for this elusive species. Singh (1994) had recorded it in Eaglenest WLS and Dujbun in Arunachal Pradesh. According to Ali *et al.* (1996), the species was scarce in Bhutan and observed singly in damp, dark, narrow, wooded ravines; it was not recorded in eastern Bhutan. Newton (2002) recorded an individual foraging in vegetable gardens and hillside streams at Mankota in Siang River valley of Arunachal Pradesh. We also caught an individual near Firmbase in evergreen forest above the River Namdapha in Namdapha Tiger Reserve, Arunachal Pradesh, on October 11, 2009.

Small-billed Scaly Thrush *Zoothera dauma*

I saw the Small-billed Scaly Thrush foraging in a roadside forest patch between Lumla and Zimmithang on October 9, 2009. Singh (1994) recorded the species in Anini, Wakro, Suchung, Mayodia, and Namdapha National Park, mostly from *c.* 300–2,700 m. According to Ali *et al.* (1996), it is 'moderately common' in Bhutan, and usually seen singly hopping about on the forest floor. Ludlow (1937) encountered it from 2,438–3,353 m in Bhutan, especially at Donga Pemi (*c.* 3,200 m) and Wamrong (3,386 m) in eastern Bhutan, where Ali *et al.* (1996) had collected a few specimens. Barua and Sharma (1999) recorded it mostly in woodlands in Kaziranga as uncommon and migratory. In Nagaland, it has been observed to be migratory (Choudhury 2001). It is reported to be an uncommon winter visitor to Nameri National Park (Barua and Sharma 2005). In southern China, the species was found to be not widespread in the survey regions during the warm and wet seasons, and was recorded only in three of the 54 sites surveyed in Jiangxi, Hainan, and Guangxi provinces (Shing *et al.* 2006).

Grey-winged Blackbird *Turdus boulboul*

I recorded the Grey-winged Blackbird on two occasions around Zimmithang in October 2009. Singh (1994) reported it from Jang (near Tawang) in temperate broadleaf forests from 120–2,450 m, and also in Seijosa, Pakke Tiger Reserve. I also recorded two birds on February 12, 2010, near the north bank (Seijosa) of Pakke Tiger Reserve, Arunachal Pradesh. According to Ali *et al.* (1996), it was not uncommon in Bhutan and seen singly or in pairs in thick forest feeding on the ground. Ludlow (1937) had recorded it throughout Bhutan from 1,829–2,743 m. Choudhury (2003) saw an individual on May 14, 2000, at Alubari (*c.* 1,900 m) during his surveys in Eaglenest and Sessa Orchid WLS, Arunachal Pradesh. Bishop (1996) recorded a bird in March 1996 inside Kaziranga

National Park. Interestingly, Birand and Pawar (2004) and Barua and Sharma (2005) did not record the species from many states of north-eastern India, including Nameri National Park (adjacent to Pakke Tiger Reserve). King *et al.* (2001) recorded it as 'uncommon' in northern Myanmar in 1999. Shing *et al.* (2006) sighted this species only once in southern China's Guangxi province, but confirmed it breeding there.

Little Forktail *Enicurus scouleri*

I recorded only one bird near a stream along the roadside between Bomdir and Zimmithang during the survey, unlike Singh (1994), who recorded it in many localities in Arunachal Pradesh, finding it fairly common at *c.* 400–3,500 m. Ali *et al.* (1996) occasionally saw it singly or in pairs, along torrential rocky hill-streams in eastern Bhutan's Gomchu (2,286 m) in March 1968. Choudhury (2003) recorded it in Eaglenest and Sessa Orchid WLS at 1,900–2,500 m. Barua and Sharma (2005) sighted it during winter in Nameri National Park, especially in Nameri river and along the Chotai nala. Birand and Pawar (2004) found it in Namdapha National Park, Arunachal Pradesh. Shing *et al.* (2006) recorded it from eight out of 54 sites surveyed in southern China.

Rufous-chinned Laughingthrush *Ianthocincla rufogularis*

On October 1, 2009, I recorded four birds near Gispu village foraging probably on berries near a crop field. In Arunachal, the species has been recorded at Hayliang (Singh 1994) and Eaglenest WLS (Choudhury 2003). Ali *et al.* (1996) mentioned that Ludlow (1937) recorded it in summer throughout Bhutan from *c.* 2,134–3,353 m, more commonly in bushes and shrubs than trees.

Rufous-winged Fulvetta *Pseudominla castaneceps*

I recorded this species only once on the way to Y-Junction from Zimmithang on October 9, 2009. Singh (1994) recorded it as common in many areas of Arunachal Pradesh, including Bomdi La and Namdapha National Park. During ZSI's expedition in Namdapha Tiger Reserve, I recorded it in many places, including Hornbill Camp and Firmbase. Ali *et al.* (1996) saw flocks of one to three dozen birds in the forest from *c.* 500–3,200 m. Choudhury (2003) recorded it from 2,400–2,500 m in Eaglenest and Sessa Orchid WLS, Arunachal Pradesh. King *et al.* (2001) found it to be common in 1998 and 1999 during surveys in northern Myanmar at *c.* 760–2,400 m. It had been reported from only one site (Cenwanglaoshan Nature Reserve, *c.* 110–1,800 m) in Guangxi province, southern China.

Blue-winged Minla *Siva cyanouroptera*

On October 10, 2009, I recorded five to seven individuals perched on a tree along with a Red-tailed Minla near Zimmithang Tourist Lodge. Singh (1994) frequently recorded this species from Pange, Upper Dikroi (Pakke Tiger Reserve), Miao-Deban (Namdapha Tiger Reserve), Arunachal Pradesh. According to Ali *et al.* (1996), it is common in flocks of about 6–12 birds, usually in mixed feeding parties with other small babblers from the foothills to about 2,300 m in the whole of Bhutan. However, Ludlow (1937) found it to be scarce and obtained specimens during November and February from *c.* 610–1,219 m in eastern Bhutan. Choudhury (2003) recorded it from *c.* 2,200–2,500 m in Eaglenest and Sessa Orchid WLS, Arunachal Pradesh. Recorded as a winter visitor to Nagaland (Choudhury 2001), and an uncommon winter visitor to Nameri National Park, Assam; often seen singly and sometimes in mixed hunting parties (Barua and Sharma 2005). It is an uncommon resident in northern Myanmar from *c.* 460–1,100 m (King *et al.* 2001).

Himalayan Aberrant Bush-Warbler
Horornis flavolivaceus

On September 29 and 30, 2009, I recorded this species between Lumla and Sherbang villages in Tawang district near roadside vegetation at *c.* 2,333 m, and this was the only record of the species during the survey. Singh (1994) recorded it in Talley valley, Arunachal Pradesh, but did not give information on its abundance. Ali *et al.* (1996) recorded it in western Bhutan, especially Gasa but not in eastern Bhutan, but Ludlow (1937) found it to be common in long grass and thick scrub in eastern Bhutan at *c.* 3,600 m. It was reported as an 'uncommon winter visitor' to Nagaland (Choudhury 2001).

Humes's Leaf-Warbler *Phylloscopus humei*

I recorded this species only once in February 2009. Ali *et al.* (1996) had captured an individual at Samchi (305 m), western Bhutan, and Ripley (1952) had collected an individual from Naga hills during his surveys in the 1950s.

Grey-hooded Warbler *Phylloscopus xanthoschistos*

I recorded this species once in February 2009. Singh (1994) recorded it from four localities (*c.* 150–2,000 m), especially in Khari (Pakke Tiger Reserve), Chakoo Road, Pange, and Anini in Arunachal Pradesh. Ali *et al.* (1996) found it to be common, frequenting taller shrubs and small trees, singly or in pairs, in spring and winter, in mixed hunting parties in eastern Bhutan's Tashiyangche, Chasam, Tashigang. Allen (2002) recorded it in Amarpur area of Assam during March 1998. Choudhury (2003) recorded it at *c.* 2,700 m in Eaglenest and Sessa Orchid WLS, Arunachal Pradesh. Barua and Sharma (1999) recorded it occasionally in secondary forests and woodlands during winter in Kaziranga National

Park, Assam. Choudhury (2001) reported it from Nagaland. Barua and Sharma (2005) recorded it as rare in Nameri National Park, Assam. Birand and Pawar (2004) recorded it from Namdapha and Mouling National Parks, Arunachal Pradesh.

Broad-billed Warbler *Tickellia hodgsoni*

I recorded the species only once on October 4, 2009, between Lumla and Zimmithang in Tawang district. Singh *et al.* (1994) recorded it from Talley valley (*c.* 2,400 m). According to Ali *et al.* (1996), Holmes observed it only a few times in western Bhutan in November 1968 and 1969. Choudhury (2003) recorded it at *c.* 2,800 m in Eaglenest and Sessa Orchid WLS, Arunachal Pradesh. However, this species is rare and localised in NE India, and its status is poorly known (del Hoyo *et al.* 2006). In northern Myanmar, King *et al.* (2001) recorded it rarely from *c.* 1,050–1,800 m. Shing *et al.* (2006) recorded it four times in Cenwanglaoshan Nature Reserve (*c.* 1,320-1,550 m), north-west Guangxi on July 31, 1999, and May 23, 2002.

Dark-sided Flycatcher *Muscicapa sibirica*

In October 2009, I recorded this species around Zimmithang. Singh (1994) had recorded it from various sites in Arunachal Pradesh, including Bomdi La, Sessa, and Talley valley at 600–2,700 m. According to Ali *et al.* (1996), it was not common in Bhutan and was seen singly or in loose parties of three to four birds, especially in spring. Ludlow (1937) found it breeding at 2,438–3,300 m in forested areas of Bhutan, and common in east and west Bhutan, including Naningphu and Deothang. Choudhury (2003) recorded it in Eaglenest and Sessa Orchid WLS below 1,900 m. It is an uncommon winter visitor to Kaziranga National Park, Assam, and seen mostly in woodlands of the Park (Barua and Sharma 1999).

Fire-capped Tit *Cephalopyrus flammiceps*

I sighted the species in February 2009, in Lumla and surrounding areas. I recorded it again there during my survey in September 2009, and also near the Lumla Circuit House and Zimmithang. Singh (1994) found it to be 'abundant' in Bomdi La (*c.* 2,500 m). Ali *et al.* (1996) mentioned it as 'scarce' in Bhutan, recording only two males from Gomchu (2,286 m) in eastern Bhutan on March 7 and 9, 1966.

Coal Tit *Periparus ater aemodius*

On October 9, 2009, I recorded the Coal Tit (probably a male and a female) on shrubs near the shores of Madhuri lake near Zimmithang. Singh (1994) recorded this species from Talley valley and Redding-Taksing areas in Arunachal Pradesh. Ali *et al.* (1996) did not record it from eastern Bhutan, but obtained records from central and western Bhutan in 1973. King *et al.* (2001) recorded it to be quite common in northern Myanmar in 1999, from *c.* 2,800–3,100 m.

Spotted Nutcracker *Nucifraga caryocatactes*

Only one individual was sighted near Bomdir (Tawang district) in February 2009. Singh (1994) had recorded it along the Sela-Jang road of Tawang district in Arunachal Pradesh from *c.* 1,800–3,100 m. Ali *et al.* (1996) record it as common, occurring in parties of four to six birds or in pairs in coniferous forests from 1,500–3,200 m. Ludlow (1937) reported that it was common throughout Bhutan from 1,830 m, and the tree-line in eastern Bhutan, especially at Donga Pemi, where Ali *et al.* (1996) had collected six specimens in November 1973. Choudhury (2003) recorded it in Eaglenest and Sessa Orchid WLS in West Kameng district, Arunachal Pradesh, from 1,800–3,200 m. It is reported as an uncommon resident in northern Myanmar, north-west of Putao at *c.* 2,600–3,100 m (King *et al.* 2001).

Wallcreeper *Tichodroma muraria*

On October 3, 2009, an individual was found emerging from a crevice in a wall stacked with boulders at Lumla Circuit House. Singh (1994) recorded it from Anini, Kibitho, and Mayodia in Arunachal Pradesh. Ali *et al.* (1996) had observed it singly, especially in newly built road-cuttings, usually at *c.* 1,000 m and above. Ali *et al.* (1996) had observed it on March 6, 1966, at Kha Ling (2,134 m), eastern Bhutan. It was also recorded in Ramalingam area of Eaglenest and Sessa Orchid WLS in West Kameng district, Arunachal Pradesh, at *c.* 1,600 m. According to Barua and Sharma (1999), it has been recorded during winter in Kaziranga National Park, Assam, where the individuals recorded could be stragglers.

Himalayan Beautiful Rosefinch *Carpodacus pulcherrimus*

In February 2009, I recorded five birds at the outskirts of Tawang city, perched on tall shrubs on the roadside, calling constantly. Singh (1994) found it to be common at Churna (near Sela Pass in Tawang district) at *c.* 3,700 m.

Scarlet Finch *Haematospiza sipahi*

On October 10, 2009, on the way to Y-Junction from Zimmithang, I recorded a male perched on the top of a tall tree and calling constantly.This was our only record of the species during the surveys. Singh (1994) had rare sightings from Broksar-Jang and Glao Lake track (Tawang district) from 600–2,300 m. Ali *et al.* (1996) recorded it as generally uncommon throughout Bhutan, but very common in loose parties in some localities, or singly feeding on berries especially at Mathangarh (*c*. 1,524 m) and Deohang (*c*. 823 m) in eastern Bhutan. However, Ludlow (1937) found it to be uncommon, occurring in open forest. Choudhury (2003) recorded it in June 2001 at Eaglenest Wildlife Sanctuary of Arunachal Pradesh. Choudhury (2001) found it uncommon and noticed its local movement pattern in Nagaland. Birand and Pawar (2004) recorded it in Mouling National Park, Arunachal Pradesh. King *et al*. (2001) recorded an individual at *c*. 1,160 m in northern Myanmar, and stated that it was uncommon and rare throughout.

Eurasian Jay *Garrulus glandarius*

In February 2009, I came across the species near Sherbang village between Lumla and Zimmithang. Similarly, on October 9, 2009, while going to Bumla from Zimmithang via Tawang, I recorded it between Y-Junction and Tawang. Singh (1994) recorded it from Anini, and Helmet Top from *c*. 2,000–2,550 m. According to Ali *et al*. (1996), it was not uncommon, occuring in pairs or small parties of four to six birds at 1,200–3,658 m, sometimes in mixed feeding parties with treepies and Spotted Nutcracker. Ludlow (1937) had reported it to be moderately common and widely distributed in open and dense forest. Specimens were collected from eastern Bhutan, at Younpu La, Gomchu, and Narphung. Choudhury (2003) recorded it from Eaglenest and Sessa Orchid WLS at 2,000–2,600 m. It is rare in northern Myanmar from *c*. 2,400 m and *c*. 2,700 m (King *et al*. 2001). It has been recorded from only one locality (Dawuling Nature Reserve (1,000–1,700 m) in southern China (Shing *et al*. 2006).

DISCUSSION

Despite the work of many birders (Athreya *et al*. 1997; Birand and Pawar 2004; Choudhury 2003; Datta 2001; Datta *et al*. 1998; King and Donahue 2006; Kumar and Singh 1999; Newton 2002; Sangha and Naoroji 2005; Sangha *et al*. 2007; Singh 1994, 1999; Kumar 2008) on the avifauna of Arunachal Pradesh, a complete list of birds of the state is lacking because of its remoteness and difficult accessibility (Sangha and Naoroji 2007). According to Srinivasan *et al*. (2010), Arunachal Pradesh is poorly surveyed and the avifauna of many areas remains inadequately documented. Due to these reasons, there are possibilities of recording new bird species and species not earlier recorded in the state.

In Zimmithang valley (a part of Zimmithang-Nelya IBA of the Eastern Himalaya), which was covered during this study, no avian surveys have been undertaken except by Kumar (2008). Thus, this survey of Tawang district, during which a total of 113 species of birds was recorded, helps fill the gaps in our knowledge of the avifauna of the state. However, I was not able to reach many high altitude areas due to logistic problems, and may have missed birds like the pheasants and the Black-necked Crane *Grus nigricollis*, besides some migratory storks and ducks, as the area is a stopover or passage site for many species which migrate from southern China and Mongolia to the plains of India. Hence, there is further need to survey the district, especially the higher reaches, where species which are common with Bhutan and southern China may occur.

The bird surveys revealed that the predominantly temperate forests of Tawang district (from 1,800 to 3,500 m) support relatively fewer species (113), compared to the rest of Arunachal Pradesh (>680 species). The bird diversity is lower in the subalpine fir and alpine vegetation found at altitudes of *c*. 3,500–4,500 m and *c*. 4,500–5,500 m respectively, and only 117 species were recorded in these two vegetation types during four visits, each of 15–20 days. Katti *et al*. (1992) recorded only 30 odd species above 2,700 m in the Arunachal Pradesh hills, compared to a much higher diversity of 174 species in the forests situated from 200–1,000 m. Kumar (2008) had recorded 81 bird species between December 2005 and November 2007 from Tawang district, including some of the areas surveyed by me.

The high altitude forests in the district are affected by various agricultural practices that could impact the bird diversity. Though more than 80% of the areas in the district are too remote for locals to cultivate, some of them have the active presence of the Indian Army. Fortunately, the entire district is dominated by the Buddhist community, so hunting is not prevalent as it is in the rest of the State.

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Appendix 1: Details of sites surveyed in Tawang district and the list of species recorded. Altitude (in metres) of each site surveyed is given at the end of Appendix in parentheses

Species	Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Black Eagle *Ictinaetus malayensis*	C	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-
Indian Spotted Eagle *Clanga hastata*	R, M	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mountain Hawk-Eagle *Nisaetus nipalensis*	O, M	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
'Steppe' Buzzard *Buteo buteo*	O	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Upland Buzzard *Buteo hemilasius*	O, M	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Oriental Honey-Buzzard *Pernis ptilorhynchus*	O, M	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Common Kestrel *Falco tinnunculus*	C, M	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Himalayan Vulture *Gyps himalayensis*	O, M	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Snow Partridge *Lerwa lerwa*	O	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Common Hill-Partridge *Arborophila torqueola*	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Kaleej Pheasant *Lophura leucomelanos*	C	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eurasian Woodcock *Scolopax rusticola*	R, M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Snow Pigeon *Columba leuconota*	C	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oriental Turtle-Dove *Streptopelia orientalis*	C, M	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	+	-	-
Ashy-headed Green-Pigeon *Treron phayrei*	O	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Wedge-tailed Green-Pigeon *Treron sphenurus*	C	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Green-billed Malkoha *Phaenicophaeus tristis*	C	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asian Barred Owlet *Glaucidium cuculoides*	C	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unidentified Nightjar *Caprimulgus* sp.	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Common (Eurasian) Hoopoe *Upupa epops*	C	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-

Appendix 1: Details of sites surveyed in Tawang district and the list of species recorded. Altitude (in metres) of each site surveyed is given in parentheses (*contd.*)

Species	Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Little Swift *Apus affinis*	C	-	+	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-
Great Barbet *Megalaima virens*	C	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Golden-throated Barbet *Megalaima franklinii*	O	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lineated Barbet *Megalaima lineata*	C	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Grey-faced Woodpecker *Picus canus*	C	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Bay Woodpecker *Blythipicus pyrrhotis*	O	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Scarlet Minivet *Pericocotus speciosus*	C	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Short-billed Minivet *Pericrocotus brevirostris*	C	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grey-chinned Minivet *Pericrocotus solaris*	C	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Red-vented Bulbul *Pycnonotus cafer*	C	-	+	-	-	+	-	-	-	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-
Himalayan Black Bulbul *Hypsipetes leucocephalus*	C	-	+	-	-	+	-	-	-	+	-	-	+	-	-	+	-	-	+	-	-	-	-	-	-
Himalayan Bulbul *Pycnonotus leucogenys*	C	-	+	-	-	+	-	-	-	+	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-
'Black-headed' Long-tailed Shrike *Lanius schach tricolor*	C	-	+	-	-	-	-	-	-	+	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-
Grey-backed Shrike *Lanius tephronotus*	C	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Rufous-breasted Accentor *Prunella strophiata*	O	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-
Alpine Accentor *Prunella collaris*	O, M	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Blue Whistling-Thrush *Myophonus caeruleus*	C	-	+	-	+	-	-	+	-	-	+	-	-	+	-	-	-	-	-	-	+	-	-	-	-
Chestnut-bellied Rock-Thrush *Monticola rufiventris*	C, M	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Long-billed Ground-Thrush *Zoothera monticola*	R	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Small-billed Scaly Thrush *Zoothera dauma*	R	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 1: Details of sites surveyed in Tawang district and the list of species recorded. Altitude (in metres) of each site surveyed is given in parentheses (*contd.*)

Species	Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Grey-winged Blackbird *Turdus boulboul*	O	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hodgson's Redstart *Phoenicurus hodgsoni*	O, M	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Plumbeous Water Redstart *Phoenicurus fuliginosus*	C	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Black Redstart *Phoenicurus ochruros*	O, M	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
White-capped River-chat *Phoenicurus leucocephalus*	C	-	-	-	+	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Golden Bush-Robin *Tarsiger chrysaeus*	O, M	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Blue-fronted Redstart *Phoenicurus frontalis*	C, M	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spotted Forktail *Enicurus maculatus*	C	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Little Forktail *Enicurus scouleri*	R	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Siberian Stonechat *Saxicola maurus*	C	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grey Bushchat *Rhodophila ferrea*	O	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Red-headed Laughingthrush *Trochalopteron erythrocephalum*	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Rufous-chinned Laughingthrush *Ianthocincla rufogularis*	C	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
White-throated Laughingthrush *Garrulax albogularis*	C	-	-	+	-	+	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Black-faced Laughingthrush *Trochalopteron affine*	C	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Streaked Laughingthrush *Trochalopteron lineatum*	C	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Striated Laughingthrush *Grammatoptila striata*	C	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rusty-cheeked Scimitar-Babbler *Pomatorhinus erythrogenys*	C	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Streak-breasted Scimitar-Babbler *Megapomatorhinus ruficollis*	C	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Red-billed Leiothrix *Leiothrix lutea*	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-

Appendix 1: Details of sites surveyed in Tawang district and the list of species recorded. Altitude (in metres) of each site surveyed is given in parentheses (*contd.*)

Species	Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Bar-throated Minla *Chrysominla strigula*	C	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Red-tailed Minla *Minla ignotincta*	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Blue-winged Minla *Siva cyanouroptera*	O, M	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Rufous-winged Fulvetta *Pseudominla castaneceps*	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Rufous-vented Yuhina *Yuhina occipitalis*	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Whiskered Yuhina *Yuhina flavicollis*	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Striated Yuhina *Staphida castaniceps*	C	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rufus Sibia *Malacias capistratus*	C	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Brown Parrotbill *Paradoxornis unicolor*	C	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hill Prinia *Prinia superciliaris*	C	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oriental White-eye *Zosterops palpebrosus*	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Himalayan Aberrant Bush Warbler *Horornis flavolivaceus*	O, M	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Humes's Leaf-Warbler *Phylloscopus humei*	C	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grey-hooded Warbler *Phylloscopus xanthoschistos*	C	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Common Tailorbird *Orthotomus sutorius*	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Broad-billed Warbler *Tickellia hodgsoni*	C	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Little Pied Flycatcher *Ficedula westermanni*	O	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Verditer Flycatcher *Eumyias thalassinus*	C	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Slaty-blue Flycatcher *Ficedula tricolor*	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-

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Species	Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Ultramarine Flycatcher *Ficedula superciliaris*	O, M	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grey-headed Canary-Flycatcher *Culicicapa ceylonensis*	C	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pied Flycatcher-Shrike *Hemipus picatus*	C	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dark-sided Flycatcher *Muscicapa sibirica*	O, M	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rufous-bellied Niltava *Niltava sundara*	C	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Green-backed Tit *Parus monticolus*	C	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Black-throated Tit *Aegithalos concinnus*	C	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
Fire-capped Tit *Cephalopyrus flammiceps*	O, M	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grey-crested Tit *Lophophanes dichrous*	C	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal Tit *Periparus ater aemodius*	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
White-tailed Nuthatch *Sitta himalayensis*	C	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sikkim Treecreeper *Certhia discolor*	O	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wallcreeper *Tichodroma muraria*	O	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orange-bellied Flowerpecker *Dicaeum trigonostigma*	R, M	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fire-tailed Sunbird *Aethopyga ignicauda*	C	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Green-tailed Sunbird *Aethopyga nipalensis*	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Streaked Spiderhunter *Arachnothera magna*	C	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow-bellied Fantail *Chelidorhynx hypoxantha*	C	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ashy Drongo *Edolius leucophaeus*	C	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 1: Details of sites surveyed in Tawang district and the list of species recorded. Altitude (in metres) of each site surveyed is given in parentheses (*contd.*)

Species	Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Black Drongo *Edolius macrocercus*	C	-	+	-	-	-	+	-	-	+	-	+	-	-	+	-	-	+	-	-	-	+	-	+	-
Nepal House-Martin *Delichon nipalense*	C	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Himalayan Beautiful Rosefinch *Carpodacus pulcherrimus*	O, M	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Scarlet Finch *Haematospiza sipahi*	O, M	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Dark-breasted Rosefinch *Procarduelis nipalensis*	O, M	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-
Eurasian Tree Sparrow *Passer montanus*	C	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	+
Cinnamon Sparrow *Passer rutilans*	C	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grey Wagtail *Motacilla cinerea*	C, M	-	+	+	+	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
White Wagtail *Motacilla alba*	C, M	-	+	-	-	-	+	-	-	-	-	+	-	-	-	-	+	+	-	-	-	-	-	-	-
Rosy Pipit *Anthus roseatus*	C	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow-billed Blue Magpie *Urocissa flavirostris*	C	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Grey Treepie *Dendrocitta formosae*	C	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eurasian Jay *Garrulus glandarius*	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-
Spotted Nutcracker *Nucifraga caryocatactes*	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Large-billed Crow *Corvus* [*macrorhynchos*] *japonicus*	C	-	+	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+

1. Sela Top (4,170 m); 2. Lumla (2,377 m); 3. Sherbang (2,333 m); 4. Thonglanglong (1,194 m); 5. Gispu (2,029 m); 6. Loudung (1,834 m); 7. Klemtang (4,328 m); Ptiso Lake (3,936 m); 9. Zimmithang (2,190 m); 10. Nelya (3,259 m); 11. BTK (1,610 m); 12. Shakti (2,026 m); 13. Gispu (2,229 m); 14. Sherbang (2,071 m); 15. Kumratsur (3,307 m); 16. Madhuri Lake (3,691 m); 17. Lumpo (2,834 m); 18. Muchat (2,409 m); 19. Y-Junction (4,282 m); 20. Nagula (4,111 m); 21. Jang (2,503 m); 22. Lhou (2,442 m); 23. Bomdir (2,534 m); 24. T. Gompha (3,612m).

Status: C-Common, O-Occasional, R-Rare, M-Migratory
+ denote sites where the species was recorded during the surveys.

DIVERSITY AND DISTRIBUTION OF ACRIDID PESTS (ORTHOPTERA: ACRIDIDAE) OF PURVANCHAL REGION, UTTAR PRADESH, INDIA

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Acridids were collected from 17 districts of Purvanchal region, eastern Uttar Pradesh, from 2010 to 2012. A total of 975 specimens belonging to 38 species representing 21 genera of 10 subfamilies were collected from crop fields, and natural habitat. The maximum number of species was recorded from Mau district and the least from Gorakhpur district. Observations made on the hosts and habitats of the 38 species is discussed.

Key words: Acrididae, pests, distribution, Purvanchal region, Uttar Pradesh

INTRODUCTION

The family Acrididae (Orthoptera) includes most of the economically important species of grasshoppers and locusts. They constitute an important group of pests and pose a constant threat to agriculture like cereal crops, pulses, vegetables, orchards, and also to grasslands and forest plantations all over the world. Locusts are the main pests in countries bordering deserts, and the devastation caused by migratory swarms of locusts is well-known. They are also an important component of the biodiversity in grassland ecosystems and food for many bird species. Most grasshoppers are oligophagous and exhibit definite host preferences, while some are polyphagous and have a wide range of food preference (Joern 1979; Mulkern 1967). Accordingly grasshoppers are classified as grass-feeders (graminivorous), forb-feeders (forbivorous) or a mix of the two (ambivorous or mixed feeders). Some grasshopper species have been reported to cause significant damage to tree seedlings (Joshi *et al.* 1999).

Uttar Pradesh (U.P.) is one of the largest states of India, presenting a very suitable climatic zone for the diversity of Acridids. Geographically, Uttar Pradesh includes eight sub-regions, namely Upper Doab, Middle Doab, Lower Doab, Rohilkhand, Bundelkhand, Baghelkhand, Awadh, and Purvanchal. Purvanchal is at the eastern end of Uttar Pradesh state, bounded by Nepal to the north, Bihar to the east, Baghelkhand region of Madhya Pradesh to the south, the Awadh region of Uttar Pradesh to the west, and Lower Doab (at Allahabad) in Uttar Pradesh to its southwest. It lies in the Indo-Gangetic Plains, one of the most fertile belts of the world, and most of the countryside is under intensive agriculture. In summer, temperature rises up to 40–45° C, while in winter temperature drops down to 6–7° C or sometimes below that. The annual rainfall is about 1,025 mm. The major rivers of this region are Ganga, Ghagra, Rapti, and Son. Wheat and rice are the main crops. Besides these, sugarcane, chick pea, pigeon pea, mustard, lentil, urad, and moong are also grown. It includes 17 districts: Basti, Siddharth Nagar, Sant Kabir Nagar, Maharajganj, Jaunpur, Azamgarh, Gorakhpur, Deoria, Kushinagar, Sant Ravidas Nagar (Bhadohi), Mirzapur, Varanasi, Ghazipur, Mau, Chandauli, Sonbhadra, and Ballia.

A number of studies have been conducted on acridids in different states or regions of India. Tandon and Shishodia (1969) worked at Nagarjuna Sagar dam in Andhra Pradesh, Tandon and Khera (1978) in Arunachal Pradesh and Julka *et al.* (1982) in Solan, Himachal Pradesh. Mondal *et al.* (1999) described 19 species of acridids infesting various field and vegetable crops of West Bengal, and discussed some ecological aspects. They made detailed notes on the nymphal taxonomy of five important species, *Acrida exaltata*, *Spathosternum prasiniferum prasiniferum*, *Aiolopus thalassinus tamulus*, *Phlaeoba infumata*, and *Atractomorpha crenulata*. Other studies were carried out by Chitra *et al.* (2000) from rice fields of Coimbatore; Ingrisch (2002) from Bhutan, Nepal and North India; Kandiben *et al.* (2004) from rice ecosystem in Madurai; while Dey and Hazra (2003) described the diversity, distribution, and ecology of grasshoppers of Greater Kolkata. Mayya *et al.* (2005) reported 24 species from Dakshina Kannada district of Karnataka. Saini and Mehta (2007) reported 73 species of Acrididae from Himachal Pradesh. Ananthasevi *et al.* (2009) reported 25 species from agricultural ecosystems in some districts of Tamil Nadu. Chandra and Gupta (2009) reported from Veerangana Durgavati Wildlife Sanctuary, Madhya Pradesh. Paulraj *et al.* (2009) recorded 21 species of Acrididae and observed their distribution on different host plants and habitats in two districts of Tamil Nadu. Senthilkumar (2010) surveyed the Acrididae of Kaziranga National Park, Assam, reporting

Table 1: Distribution of species in the surveyed districts of Purvanchal Region of U.P.

S.No	Acridoid Species	Basti	Siddharth Nagar	Sant Kabir Nagar	Maharajganj	Jaunpur	Azamgarh	Gorakhpur	Deoria	Kushinagar	Sant Ravidas Nagar	Mirzapur	Varanasi	Ghazipur	Mau	Chandauli	Sonbhadra	Ballia
	Subfamily: Oxyinae																	
1	*Oxya fuscovittata*	-	+	-	+	-	-	+	+	+	-	-	-	-	+	+	-	-
2	*Oxya hyla hyla*	+	+	+	+	-	+	+	+	+	-	-	+	-	+	+	+	-
3	*Oxya hyla intricata*	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	*Oxya japonica japonica*	+	+	+	+	-	-	-	-	-	-	-	+	-	+	-	-	-
5	*Oxya grandis*	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	*Oxya velox*	+	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-
7	*Oxya chinensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
	Subfamily: Spathosterninae																	
8	*Spathosternum prasiniferum prasiniferum*	+	-	-	-	+	-	-	+	-	+	+	+	+	+	+	+	+
	Subfamily: Hemiacridinae																	
9	*Hieroglyphus banian*	-	-	-	-	-	+	-	-	+	-	+	+	+	+	+	-	-
10	*Hieroglyphus nigrorepletus*	-	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-
11	*Hieroglyphus concolor*	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
12	*Hieroglyphus annulicornis*	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
13	*Hieroglyphus oryzivorus*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
	Subfamily: Catantopinae																	
14	*Xenocatantops karnyi*	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-
15	*Diabolocatantops pinguis innotabilis*	-	-	-	-	+	-	-	+	-	-	-	+	-	+	-	-	-
16	*Choroedocus illustris*	-	-	-	+	-	-	+	+	-	-	-	-	-	-	-	-	-
17	*Choroedocus robustus*	-	+	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-
	Subfamily: Cyrtacanthacridinae																	
18	*Cyrtacanthacris tatarica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
	Subfamily: Eyprepocnemidinae																	
19	*Tylotropidius varicornis*	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
20	*Eyprepocnemis alacris alacris*	-	+	-	+	-	+	-	-	+	+	-	+	-	+	-	+	-
21	*Heteracris nobilis*	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	+
	Subfamily: Tropidopolinae																	
22	*Tristria pulvinata*	-	-	-	-	+	-	-	-	-	+	+	+	-	+	-	-	-

Table 1: Distribution of species in the surveyed districts of Purvanchal Region of U.P. (*contd.*)

S.No	Acridoid Species	Basti	Siddharth Nagar	Sant Kabir Nagar	Maharajganj	Jaunpur	Azamgarh	Gorakhpur	Deoria	Kushinagar	Sant Ravidas Nagar	Mirzapur	Varanasi	Ghazipur	Mau	Chandauli	Sonbhadra	Ballia
	Subfamily: Acridinae																	
23	*Acrida exaltata*	+	+	+	+	+	+	+	+	+	-	-	-	-	-	+	+	+
24	*Acrida gigantea*	+	+	-	+	-	+	+	+	+	-	-	-	-	+	-	+	-
25	*Phlaeoba infumata*	-	-	-	-	+	+	-	-	-	+	+	+	+	+	+	-	-
26	*Phlaeoba panteli*	-	-	-	-	-	+	-	-	-	-	-	+	+	+	+	-	-
	Subfamily: Gomphocerinae																	
27	*Aulacobothrus luteipes luteipes*	-	-	-	-	-	-	-	-	-	+	-	+	-	-	+	+	-
	Subfamily: Oedipodinae																	
28	*Trilophidia annulata*	+	-	+	-	+	+	-	-	-	+	+	+	+	+	+	+	+
29	*Trilophidia repleta*	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
30	*Aiolopus simulatrix simulatrix*	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	-	-
31	*Aiolopus thalassinus thalassinus*	-	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-
32	*Aiolopus thalassinus tamulus*	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	+
33	*Oedaleus abruptus*	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	+	+
34	*Oedaleus senegalensis*	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
35	*Oedipoda miniata*	-	-	-	-	+	-	-	-	-	+	-	+	-	+	-	-	+
36	*Gastrimargus africanus*	-	-	-	-	-	+	-	-	-	-	-	-	+	-	+	+	-
37	*Locusta migratoria migratoria*	-	-	-	-	-	-	-	-	-	+	+	-	-	+	-	-	-
38	*Chloebora grossa*	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-

19 species. Shishodia and Gupta (2009) listed 81 species in a checklist of Acrididae of Himachal Pradesh. Nayeem and Usmani (2011, 2012) reported 31 species of superfamily Acridoidea, including family Acrididae, from southern and southwestern Bihar, and 41 species from Jharkhand.

From Uttar Pradesh, Usmani *et al.* (2012a) discussed the diversity, distribution, and taxonomy of 29 species of Acridoidea of Aligarh Fort, Aligarh, Uttar Pradesh. Usmani *et al.* (2012b) studied the diversity and taxonomy of Acridoid pests of pulses from Uttar Pradesh. Akhtar *et al.* (2012) reported the species diversity and abundance of grasshoppers in rice ecosystem of Uttar Pradesh. However, there has been no specific study of the Acrididae of Purvanchal region, and this paper is the first such report.

METHODOLOGY

Grasshopper specimens were collected from all the districts of Purvanchal region, Uttar Pradesh, during 2010–2012, from various agricultural and non-agricultural areas. Specimens were collected by net sweeping and hand picking methods and killed in a bottle with ethyl acetate. The grasshoppers were identified through their morphological and genitalic characters, using stereo-microscope.

Table 2: Species richness of grasshoppers in the districts of Purvanchal region of Uttar Pradesh

S. No.	Districts	No. of genera	No. of subfamilies	No. of species
1	Basti	5	4	8
2	Siddharth Nagar	5	5	11
3	Sant Kabir Nagar	4	3	9
4	Maharajganj	5	5	10
5	Jaunpur	9	5	11
6	Azamgarh	10	6	16
7	Gorakhpur	4	4	6
8	Deoria	8	8	14
9	Kushinagar	5	5	7
10	Sant Ravidas Nagar (Bhadohi)	8	6	8
11	Mirzapur	7	5	7
12	Varanasi	13	9	15
13	Ghazipur	7	5	10
14	Mau	13	8	17
15	Chandauli	9	6	11
16	Sonbhadra	9	7	10
17	Ballia	7	4	7

RESULTS

A total of 975 specimens of grasshoppers (Acrididae) were collected from 17 districts of Purvanchal region representing 38 species, 21 genera, and 10 subfamilies of Acrididae (Table 1). The maximum numbers of species were recorded from Mau district (17) followed by Azamgarh (16), Varanasi (15) and Deoria (14), while the minimum number (6) was from Gorakhpur district (Table 2).

DISCUSSION

The diversity and distribution of the species greatly depends on abiotic as well as biotic factors. Abiotic factors like temperature, humidity, and rainfall affect the population of acridids in nature. Population of grasshoppers may also depend on the vegetation of the cultivated and uncultivated areas. In this study, 16 species were collected only from agricultural (cultivated) areas, 9 only from natural habitats, and 13 species were recorded in both cultivated and natural habitats.

District Mau represents the maximum diversity and species richness (17) of acridids, followed by Azamgarh (16), while the minimum number of species (6) was recorded in Gorakhpur district (Table 2).

Among the species recorded, maximum numbers belong to subfamily Oedipodinae (29%) followed by Oxyinae (18%), Hemiacridinae (13%), Acridinae, Catanopinae (10% each), and Eyprepocnemidinae (8%) while the minimum numbers of species belong to Cyrtacanthacridinae, Gomphocerinae, Spathosterninae, and Tropidopolinae (3% each) (Table 3). *Spathosternum prasiniferum* is the most dominant species in this area, followed by *Acrida exaltata* and *Oxya hyla hyla* (Table 3). Out of these three species, *Oxya hyla hyla* is a common and destructive pest of paddy, while the other two species are polyphagous and can cause harm to many crops like paddy, wheat, maize, jowar, bajra, oilseed plants, and many vegetable and pulse crops, thus it is found in both cultivated and uncultivated areas (Table 4).

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Table 3: List of species recorded in the Purvanchal region of Uttar Pradesh

S. No.	Species	No. of males	No. of females	No. of Nymphs	Total
Subfamily: Oxyinae					
1.	*Oxya fuscovittata*	13	37	-	50
2.	*Oxya hyla hyla*	40	80	-	120
3.	*Oxya hyla intricata*	2	4	-	6
4.	*Oxya japonica japonica*	4	8	-	12
5.	*Oxya grandis*	1	1	-	2
6.	*Oxya velox*	1	4	-	5
7.	*Oxya chinensis*	-	1	-	1
Subfamily: Spathosterninae					
8.	*Spathosternum prasiniferum prasiniferum*	67	73	46	186
Subfamily: Hemiacridinae					
9.	*Hieroglyphus banian*	11	31	-	42
10.	*Hieroglyphus nigrorepletus*	5	4	-	9
11.	*Hieroglyphus concolor*	1	1	-	2
12.	*Hieroglyphus annulicornis*	-	1	-	1
13.	*Hieroglyphus oryzivorus*	1	-	-	1
Subfamily: Catantopinae					
14.	*Xenocatantops karnyi*	1	2	-	3
15.	*Diabolocatantops pinguis innotabilis*	4	5	-	9
16.	*Choroedocus illustris*	2	1	-	3
17.	*Choroedocus robustus*	4	3	-	7
Subfamily: Cyrtacanthacridinae					
18.	*Cyrtacanthacris tatarica*	1	1	-	2
Subfamily: Eyprepocnemidinae					
19.	*Tylotropidius varicornis*	-	1	-	1
20.	*Eyprepocnemis alacris*	10	10	-	20
21.	*Heteracris nobilis*	7	12	-	19
Subfamily: Tropidopolinae					
22.	*Tristria pulvinata*	6	6	-	12
Subfamily: Acridinae					
23.	*Acrida exaltata*	56	42	53	151
24.	*Acrida gigantea*	25	20	28	73
25.	*Phlaeoba infumata*	11	15	-	26
26.	*Phlaeoba panteli*	5	7	-	12
Subfamily: Gomphocerinae					
27.	*Aulacobothrus luteipes luteipes*	3	2	-	5
Subfamily: Oedipodinae					
28.	*Trilophidia annulata*	19	23	32	74
29.	*Trilophidia repleta*	1	1	3	5
30.	*Aiolopus simulatrix*	24	23	-	47
31.	*Aiolopus thalassinus thalassinus*	5	5	-	10
32.	*Aiolopus thalassinus tamulus*	9	9	-	18
33.	*Oedaleus abruptus*	7	12	-	19
34.	*Oedaleus senegalensis*	-	2	-	2
35.	*Oedipoda miniata*	6	2	-	8
36.	*Gastrimargus africanus*	3	3	-	6
37.	*Locusta migratoria migratoria*	5	-	-	5
38.	*Chloebora grossa*	-	1	-	1
Total		**360**	**453**	**162**	**975**

Table 4: Distribution of grasshopper species in different habitats

S. No.	Species	Host Plant	Habitat
Subfamily: Oxyinae			
1.	*Oxya fuscovittata*	Paddy	Agriculture fields
2.	*Oxya hyla hyla*	Paddy	Agriculture fields
3.	*Oxya hyla intricata*	Paddy	Agriculture fields
4.	*Oxya japonica japonica*	Paddy	Agriculture fields
5.	*Oxya grandis*	Paddy	Agriculture fields
6.	*Oxya velox*	Paddy	Agriculture fields
7.	*Oxya chinensis*	Paddy	Agriculture fields
Subfamily: Spathosterninae			
8.	*Spathosternum prasiniferum prasiniferum*	Grass	Both (agricultural and non-agricultural areas)
Subfamily: Hemiacridinae			
9.	*Hieroglyphus banian*	Paddy/Grass	Agriculture fields
10.	*Hieroglyphus nigrorepletus*	Paddy/Grass	Agriculture fields
11.	*Hieroglyphus concolor*	Paddy/Grass	Agriculture fields
12.	*Hieroglyphus annulicornis*	Paddy/Grass	Agriculture fields
13.	*Hieroglyphus oryzivorus*	Paddy/Grass	Agriculture fields
Subfamily: Catantopinae			
14.	*Xenocatantops karnyi*	Grass/bushes	Non-agricultural area
15.	*Diabolocatantops pinguis innotabilis*	Grass/bushes	Non-agricultural area

Table 4: Distribution of grasshopper species in different habitats (*contd.*)

S. No.	Species	Host Plant	Habitat
16.	*Choroedocus illustris*	Bushes	Non-agricultural area
17.	*Choroedocus robustus*	Bushes	Non-agricultural area
Subfamily: Cyrtacanthacridinae			
18.	*Cyrtacanthacris tatarica*	Bushes	Non-agricultural area
Subfamily: Eyprepocnemidinae			
19.	*Tylotropidius varicornis*	Grass	Agriculture fields
20.	*Eyprepocnemis alacris*	Bushes	Non-agricultural area
21.	*Heteracris nobilis*	Grass	Agriculture fields
Subfamily: Tropidopolinae			
22.	*Tristria pulvinata*	Grass	Agriculture fields
Subfamily: Acridinae			
23.	*Acrida exaltata*	Grass	Both
24.	*Acrida gigantea*	Grass	Both
25.	*Phlaeoba infumata*	Grass	Both
26.	*Phlaeoba panteli*	Grass	Both
Subfamily: Gomphocerinae			
27.	*Aulacobothrus luteipes luteipes*	Grass	Agriculture fields
Subfamily: Oedipodinae			
28.	*Trilophidia annulata*	Grass	Both
29.	*Trilophidia repleta*	Grass	Both
30.	*Aiolopus simulatrix*	Grass	Both
31.	*Aiolopus thalassinus thalassinus*	Grass	Both
32.	*Aiolopus thalassinus tamulus*	Grass	Both
33.	*Oedaleus abruptus*	Grass/Bushes	Both
34.	*Oedaleus senegalensis*	Grass/Bushes	Both
35.	*Oedipoda miniata*	Grass/Bushes	Both
36.	*Gastrimargus africanus*	Grass/Bushes	Non-agricultural area
37.	*Locusta migratoria migratoria*	Grass/Bushes	Non-agricultural area
38.	*Chloebora grossa*	Grass	Non-agricultural area

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FLORISTIC DIVERSITY OF THE KUNJAPURI SACRED GROVE, GARHWAL HIMALAYA, INDIA

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The floristic diversity of the Kunjapuri sacred grove in Garhwal Himalaya was studied from 2006 to 2007. A total of 239 plant species belonging to 78 families and 207 genera were recorded. The representation of dicotyledons, monocots, and gymnosperms was 84.62%, 14.10%, and 1.28%, respectively. Asteraceae was the most dominant family with 23 genera and 24 species, followed by Poaceae (20 genera and 22 species), Lamiaceae (13 genera and 16 species), and Acanthaceae and Fabaceae (9 genera and 11 species each). In recent years, due to increasing pressures on natural resources there has been a weakening of religious beliefs, affecting the survival of sacred groves. Sacred groves, which were maintained in the form of untouched ecosystems, dedicated to a deity, are nowadays being looked upon as important sources of natural resources or revenue. Hence, they cannot survive on the basis of spiritual beliefs, unlike in the past, and there is an urgent need to implement rural participatory management practices with the help of the village community, temple authorities, and forest committees to conserve them.

Key words: Kunjapuri, sacred forest, floristic diversity, Garhwal Himalaya

INTRODUCTION

India is a land of diversity of natural resources and traditions. Since time immemorial, conservation of natural resources has been part of the religious traditions of several Indian communities. One such significant tradition of nature conservation is that of sacred forest or groves. A sacred grove is a patch of forest protected by the local people, surrounding a temple or dedicated to some deity, and being virgin forests, generally harbouring rich biodiversity. Besides being centres of high species richness (Dash and Chauhan 2002; Jamir and Pandey 2002, 2003; Upadhaya *et al.* 2003), these act as gene pools and provide refuge to a large number of endemic, endangered, and threatened species (Dash and Chauhan 2002; Jamir and Pandey 2002, 2003), and render ecological services, such as being a source of perennial water, maintaining local micro-environmental conditions, and helping in biogeochemical cycles (Upadhaya 2002).

Set amidst a mosaic of landscape elements like shifting cultivation, fields and fallows, permanent agricultural areas, savannah and secondary forests, sacred forests protected several valuable food plants and scores of medicinal plants. Despite rising human pressures, sacred groves shelter many elements of the biota, which may have vanished elsewhere in the local landscape (Chandran *et al.* 1998). Their role in the conservation of biodiversity has been recognised by several workers (Chandrakanth *et al.* 2004; Chandrakanth and Romm 1991; Dash 2005; Dash and Chauhan 2002; Gadgil and Vartak 1976; Haridasan and Rao 1985; Khan *et al.* 1997; Kosambi 1962; Sukumaran and Jeeva 2008; Sukumaran *et al.* 2008).

In the past few years, the demands on natural resources have resulted in a weakening of religious beliefs. There has been an increase in the number of reports of degradation activities, affecting the institutional foundations of sacred forests in India. This is due to several reasons like fading institutional identity of these traditional forests with the advent of national forest policies (Chandrakanth and Romm 1991), commercial agriculture, changing demographics, and weak property rights (Chandrakanth *et al.* 2004).

Garhwal Himalaya is referred to as Land of the Gods due to the numerous important religious shrines located here, besides the confluence of five tributaries of the sacred river Ganga. Although, biological diversity of the Himalaya is rich, little is known about the sacred forests of this region (Anthwal *et al.* 2006). To know about these sacred forests there is an urgent need for extensive research studies on the diversity and conservation status of their precious plant wealth. This will help in developing appropriate strategy for the conservation of sacred groves. Keeping these things in view, the present study was conducted in the Kunjapuri sacred grove to document its floristic diversity.

STUDY AREA

The study was carried out in the Narendra Nagar Forest

Division (30° 10'–30° 52" N; 78° 8' 15"–79° 2' 45" E) of Tehri district in the Garhwal region of Himalaya. The total area of the forest division is 62,023.26 ha having three distinct forest ranges, (i) Maniknath Forest Range, (ii) Saklana Forest Range, and (iii) Shivpuri Forest Range. The study site – Kunjapuri (30° 10'–30° 52" N; 78° 8' 15"–79° 2' 45" E) – falls in the Shivpuri Forest Range. The total area of this range is *c.* 19,427.56 ha. The entire forest division is mountainous hilly with precipitous slopes. Kunjapuri is situated at an altitude of 1,645 m above msl and is located at about 35 km from Rishikesh on the Rishikesh-Gangotri road (Rawat *et al.* 2011).

Kunjapuri is one of the 52 Siddhapeeths of India, dedicated to goddess Kunjapuri Devi, and the Kunjapuri temple is situated on the highest peak of the region. It lies in the temperate region encompassing three major ecosystems, forest, grassland, and hill terrace. It lends a panoramic view of the snow-clad Himalayan range in the north (Chaukhamba ranges) and an exhilarating view of the rivers Ganga, Rishikesh, Haridwar, Doon Valley, and Shiwalik hills in the south. About 150–200 pilgrims and 10–25 foreign tourists visit the temple every day (Rawat *et al.* 2011).

METHODS

The entire Kunjapuri forest was surveyed at monthly intervals during 2006–2007. Plant specimens collected were processed following Jain and Rao (1977) and were identified at the Systematic Botany Discipline of Forest Research Institute (FRI), Dehradun and Wildlife Institute of India (WII), Dehradun. Identified plants were mounted on herbarium sheets and deposited at the Forest Ecology and Environment Division, Forest Research Institute, Dehradun. All the identified species were arranged according to Bentham and Hooker's system of classification (Bentham and Hooker 1862–1883).

RESULTS AND DISCUSSION

A total of 239 plant species belonging to 78 families and 207 genera were recorded (Table 1). Of these, 66 families (84.62%) are dicotyledonous and 11 families (14.10%) are monocotyledonous. Gymnosperms contributed only 1.28% (one family) to the total families and 0.84% (two species) to the total species of the area. Only 43 monocotyledonous species (17.99%) from 37 genera (17.87%) were reported as compared to 194 (81.17%) dicotyledonous species from 168 genera (81.16%).

Table 1: Floristic features of the study area

Components	Family	Genus	Species
ANGIOSPERMS			
Dicotyledons	66	168	194
Percent Contribution	84.62	81.16	81.17
Monocotyledons	11	37	43
Percent Contribution	14.10	17.87	17.99
GYMNOSPERMS	1	2	2
Percent Contribution	1.28	0.97	0.84
Total	78	207	239

Species richness of the present study site is within the range of 80 and 388 plant species reported for various sacred forests of India (Bhakat 2009; Bhakat *et al.* 2008; Dash and Chauhan 2002; Laloo *et al.* 2006; Sukumaran and Jeeva 2008; Sukumaran *et al.* 2008). Contribution of monocots (17.87%) in the present study is slightly higher than these studies, which averages *c.* 11.23%. The reason for this may be that all these studies are from tropical forests and Kunjapuri is a temperate forest having more harsh environmental conditions, which is not favourable for tree growth as snowfall prevents the growth and establishment of tree saplings.

Asteraceae was the most dominant family with 23 genera and 24 species followed by Poaceae (20 genera and 22 species), Lamiaceae (13 genera and 16 species), and Acanthaceae and Fabaceae (9 genera and 11 species each). Other important contributing families were Euphorbiaceae, Rosaceae, Rubiaceae, Verbenaceae, and Urticaceae (Table 2). *Clematis* of the family Ranunculaceae was the most dominant genus (5 species), followed by *Rhamnus* (4 species) of Rhamnaceae, *Rubus* (3 species) of Rosaceae, and *Plectranthus* (3 species) of Lamiaceae. Gadgil *et al.* (1996) and Sukumaran *et al.* (2008) reported Fabaceae as the most dominant family and *Ficus* the most common genus (as no species of *Ficus* is traditionally felled) in the sacred groves. But, being a temperate forest *Ficus* is not common in Kunjapuri forest. Further, the dominance of Asteraceae and Poaceae shows that the study site is highly disturbed.

The majority of the plants recorded from the Kunjapuri forest are economically important. The medicinal plants ranked first with 130 species; 64 species were used as fodder and 11 species were used as fuel-wood species. Some species are multi-use. *Quercus leucotrichophora* (Oak), a worshipped multi-use tree, was the most dominant tree of the study site. It is an important component of the mountain forest ecosystem due to its use as fodder, fuel-wood, and wood-charcoal. It is also used for thatching. Ecologically, *Q. leucotrichophora* helps in improving the soil fertility through efficient nutrient cycling, and conserving soil moisture through humus build-up in the soil and partly through a deeply placed root system (Anthwal *et al.* 2006). Other 40 species, regarded as multi-use species, includes timber, non-timber forest produce,

Table 2: Species reported from the Kunjapuri Siddhapeeth as per Bentham and Hooker Classification

Family	Species	Habit	Local names; Uses
ANGIOSPERMS			
Dicotyledons			
Ranunculaceae	*Anemone vitifolia* Buch.-Ham. ex DC.	H	Mudeela; M, Fd
	Clematis grata Wall.	C	Laguli; Fd
	Clematis barbellata Edgew.	C	Kanrya; Fd
	Clematis montana Buch.-Ham. ex DC.	C	Kujju; Mu
	Clematis roylei Rehder	C	Konia; Mu
	Clematis buchananiana DC.	C	Kanguli; M
	Delphinium denudatum Wall. ex Hook. f. & Th.	H	Nirbisi; M
	Thallictrum foliosum DC.	H	Mamira; M
Menispermaceae	*Cissampelos pariera* L.	C	Parha; M
	Cocculus laurifolius DC.	ST	Tilfada; Fw
	Stephania glabra (Roxb.) Miers	C	Gindaru; M
Berberidaceae	*Berberis asiatica* Roxb. ex DC.	S	Kilmora; M, Fw
Brassicaceae	*Brassica campestris* L.	H	Laiya, Mu
Flacourtiaceae	*Flacourtia indica* (Burm. f.) Merrill	S	Kandai; M, Fd
Violaceae	*Viola serpens* Wall.	H	Kauru; M
Polygalaceae	*Polygala abyssinica* R. Br. ex Fresen	H	Fd
Caryophyllaceae	*Stellaria media* (L.) Villars	H	Bandyalu; Fd, M
Hypericaceae	*Hypericum uralum* Buch.-Ham ex D. Don	S	Bhatla; M
Malvaceae	*Hibiscus rosa-sinensis* L.*	S	Gudhal; M
	Sida cordifolia L.	H	Balu; M, Mu
Tiliaceae	*Grewia optiva* Drumm ex Burret	T	Bhimal; Fw, Fd
Linaceae	*Reinwardtia trigyna* Planch.	S	Phiunli; Mu
Geraniaceae	*Geranium nepalense* Sweet	H	Phori; M
Oxalidaceae	*Oxalis corniculata* L.	H	Bhilmori; M
Balsaminaceae	*Impatiens balsamina* L.	H	Phyaktuli; Mu
	Impatiens scabrida DC.	H	Ban-til; Mu
Rutaceae	*Boenninghausenia albiflora* (Hook.) Reichb. ex Meisn.	H	Pissumar, Upniyaghas; M
	Murraya koenigii Spreng.	S	Gandela; M, Mu
	Zanthoxylum alatum Roxb.	S/ST	Timru; M, Mu
Meliaceae	*Toona serrata* M. Roem.	T	Tun; Fw, Mu, M
Rhamnaceae	*Berchemia edgeworthii* Lawson	S	Angari; M
	Helinus lanceolatus Brandis	S	Kukriya; Fd
	Rhamnus persica Boiss.	S	Chirla; Fd
	Rhamnus procumbens Edgew.	S	Dadmiya; Mu
	Rhamnus triquetra (Wall.) Lawson	ST	Ghauta; Fw, Mu
	Rhamnus virgatus Roxb.	ST	Chentuli; Fw, M
	Sageretia filiformis (Roth. ex Schult) G. Don	ST	Gonta; Mu
Vitaceae	*Cissus repanda* Vahl	C	Bhel chapru; Fd, M
	Parthenocissus semicordata Planch.	C	Bhunera; Fd
Sapindaceae	*Dodonaea viscosa* Jacq.*	S	Sinatha; Fw, M
Hippocastanaceae	*Aesculus indica* (Colebr. ex Camb.) Hook.*	T	Pangar; Fd, M
Aceraceae	*Acer oblongum* Wall. ex DC.	T	Kirmoli; Mu
Anacardiaceae	*Rhus parviflora* Roxb.	S	Tungla; M
Fabaceae	*Astragalus leucocephalus* Graham	H	Rudravanti; Fd
	Atylosia scarabaeoides (L.) Benth.	Tw	Bandal; Fd
	Crotalaria albida B. Heyne ex Roth	H	Chunchni; M
	Desmodium tiliaefolium G. Don	S	Chamlai; M
	Indigofera heterantha Wall.	S	Kathi; Fd, M
	Indigofera tinctoria L.	S	Sakina; Fd

Table 2: Species reported from the Kunjapuri Siddhapeeth as per Bentham and Hooker Classification (*contd.*)

Family	Species	Habit	Local names; Uses
	Lespedeza sericea (Thunb.) Miq.	US	Khunju
	Lespedeza gerardiana Graham	US	Khunya; M
	Shuteria involucrata Wight & Arn.	C	Fd
	Tephrosia candida DC.	S	Ban-tor; Fd
	Uraria lagopus DC.	US	Pithari; M
Caesalpiniaceae	*Bauhinia variegata* L.	T	Guiral; Fd
	Caesalpinia bonduc (L.) Roxb.	C	Karvaunj; M, Fd
	Caesalpinia pulcherrima (L.) Sw.	S	Golutora; M
Mimosaceae	*Mimosa himalayana* Gamble	S	Kingrei; M, Fd
	Mimosa pudica L.	H	Chui-mui; M
Rosaceae	*Duchesnea indica* (Andrews) Focke	H	Bhium-kaphal; M
	Prunus cerasoides D. Don	T	Payan; Mu, Fd
	Prunus persica (L.) Batsch*	T	Aaru; M, Mu
	Spiraea canescens D. Don	S	Jhair-mairala; Fd, Mu
	Pyrus communis L.*	T	Nashpati; Mu
	Pyrus pashia Buch.-Ham. ex D. Don	T	Mehul; Fd, M
	Rubus ellipticus Sm.	S	Hinssar; Mu
	Rubus paniculatus Sm.	S	Kala hinssar; M
	Rubus niveus Thunb.	S	Anchu; Mu
	Fragaria indica Andrews	H	Kaphal; M
Saxifragaceae	*Bergenia ciliata* (Haw.) Sternb	H	Sipara; M
Melanostomaceae	*Osbeckia stellata* Buch.-Ham. ex D. Don	S	Kuktia-makuri; M
Lythraceae	*Lagerstroemia indica* L.	S	Gulbahar; M, Fd
	Woodfordia fruticosa Kurz	S	Dhaula; M, Fd
Onagraceae	*Oenothera rosea* Aiton	H	-
Begoniaceae	*Begonia picta* Sm.	H	Patharchatta; M
Apiaceae (Umbelliferae)	*Bupleurum falcatum* L.	H	Jangli-jeera; M
	Centella asiatica (L.) Urb.	H	Brahmi; M
	Pimpinella diversifolia DC.	H	Teroi; M
	Selinum tenuifolium Wall.	H	Moor; M
	Selinum vaginatum C.B. Clarke	H	Bhulkeshi; M
Caprifoliaceae	*Abelia grandiflora* (Andre) Rehd.*	S	Kamera; Fd
Rubiaceae	*Galium rotundifolium* L.	H	Kuri; M
	Leptodermis lanceolata Wall.	S	Padera; Fd, M
	Hamiltonia suaveolens Roxb.	S	Padar; M, Fd
	Randia tetrasperma Benth. & Hook. f. ex Brand.	S	Ghara; Fw, M
	Randia uliginosa Poir.	T	Pindru; M, Fd
	Rubia cordifolia L.	C	Lichkuru; M
Valerianaceae	*Valeriana jatamansi* Jones	H	Balchhari; M
Dipsacaceae	*Dipsacus inermis* Wall.	H	Phulee; M
Asteraceae	*Ainsliaea aptera* DC.	H	Kauru; M
	Ageratum conyzoides L.	H	Gundrya; M
	Anaphalis cinnamomea C.B. Clarke	H	Bugliya; M
	Anaphalis contorta Hook. f.	H	Bugla; M
	Artemisia vulgaris L.	H	Kunjoa; M
	Bidens biternata (Lour.) Merr. & Sherff	H	Kuria; M
	Blumea aromatica DC.	US	-
	Cirsium argyracanthum DC.	H	Kardra; M
	Conyza stricta Willd.	H	-
	Dichrocephala latifolia DC.	H	-
	Erigeron acuminatus (Wall.) Wall. ex Nees	H	-

Table 2: Species reported from the Kunjapuri Siddhapeeth as per Bentham and Hooker Classification (*contd.*)

Family	Species	Habit	Local names; Uses
	Galinsoga ciliata S.F. Blake	H	Fd
	Gerbera lanuginosa Sch. Bip.	H	Kapasi; M
	Echinops echinatus Roxb.	H	-
	Eupatorium adenophorum Spreng	S	Gandela; M
	Inula cuspidata C.B. Clarke	S	Jhuri; M
	Launaea procumbens (Roxb.) Ramayya & Rajagopal	H	-
	Myriactis wallichii Less.	H	-
	Parthenium hysterophorus L.	H	Gajar-ghas;
	Saussurea heteromalla (D. Don) Hand.-Mazz.	H	M
	Senecio nudicaulis Buch.-Ham. ex D. Don	H	Neelkanthi; M
	Sonchus asper (L.) Hill	H	Pili dudhi; M
	Tridax procumbens L.	H	Kumra; M
	Xanthium strumarium L.	H	Kurou
Ericaceae	*Lyonia ovalifolia* (Wall.) Drude	T	Aanyar; Fw, M
Myrsinaceae	*Myrsine africana* L.	S	Chupra; M
Oleaceae	*Jasminum humile* L.	S	Surmarhi; M
	Fraxinus micrantha Lingelsh.	T	Angu; M
	Olea glandulifera Desf.	T	Gaid; Fd, M, Mu
Apocynaceae	*Ichnocarpus frutescens* (L.) R. Br.	C	Kali Dudhi; M
	Nerium odorum Soland.*	S	Kaner; M
	Thevetia neriifolia Juss. ex Steud.*	S	Pili kaner; Mu
	Plumeria rubra L.*	T	Parijat; Mu
	Tabernaemontana divaricata R. Br. ex Roem. & Schult*	S	Chandni; M
Gentianaceae	*Swertia chirayita* (Roxb. ex Fleming) Karsten	US	Chirayita; M
Boraginaceae	*Cynoglossum zeylanicum* Thunb. ex Lehm.	H	Andhahuli; M
Cuscutaceae	*Cuscuta reflexa* Roxb.	P	Aakash laguli; M
Convovulaceae	*Ipomoea purpurea* (L.) Roth	H	Kaphjlagla; Fd, M
Solanaceae	*Solanum nigrum* L.	H	Kirmoi; M
	Nicandra physalodes Scop.	H	Tamburkya; M
Scrophulariacee	*Lindenbergia urticifolia* Lehm.	H	Makria ghas; M
	Lindernia crustacea (L.) F. Muell.	H	M
	Striga asiatica (L.) Kuntze	H	Agia; M
Gesneriaceae	*Rhynchoglossum obliquum* Blume	H	-
Acanthaceae	*Aechmanthera gossypina* Nees	S	Jaundela; Mu
	Barleria cristata L.	US	Saundi; M
	Dicliptera roxburghiana Nees	H	Kuthhi; Fd, M
	Hemigraphis rupestris T. Anderson	H	Mu
	Justicia adhatoda L.	S	Basingu; M
	Lepidagathis incurva Buch.-Ham. ex D. Don	H	-
	Lepidagathis cuspidata Nees	S	Kalela; M
	Rungia pectinata (L.) Nees	H	Fd
	Strobilanthes atropurpurea Nees	S	Kangdai
	Strobilanthes dalhousieana C.B. Clarke	S	Mu
	Thunbergia erecta T. Anders.*	US	Karwi; Fd, M
Verbenaceae	*Caryopteris grata* Benth. & Hook.f.	S	Fd, M
	Caryopteris wallichiana Schauer	S	Fd, M
	Holmskioldia sanguinea Retz.*	S	Ramkatori; M
	Lantana camara L.	S	Kuri, Fw
	Verbena officinalis L.	H	-
	Vitex negundo L.	S	Samalu; M, Mu
Lamiaceae	*Calamintha umbrosa* Fisch. & C.A. Mey.	H	Birchee; M
	Colebrookea oppositifolia Smith	S	Bindu; M

Table 2: Species reported from the Kunjapuri Siddhapeeth as per Bentham and Hooker Classification (*contd.*)

Family	Species	Habit	Local names; Uses
	Craniotome versicolor Reich.	H	-
	Coleus forskohlii Briq.	H	M
	Coleus barbatus (Andr.) Benth.	H	M
	Leucas lanata Benth.	H	Gumma; M
	Mentha piperita L.	H	Pudina; M
	Micromeria biflora Benth.	H	Ban-ajwain; M
	Nepeta discolor Royle ex Benth.	H	-
	Ocimum sanctum L.	H	Tulsi; M
	Plectranthus coetsa Buch.-Ham. ex D. Don	H	-
	Plectranthus gerardianus Benth.	S	-
	Plectranthus rugosus Wall.	S	-
	Salvia officinalis L.	H	-
	Scutellaria linearis Benth.	H	-
	Teucrium royleanum Wall. ex Benth.	H	-
Amaranthaceae	*Achyranthes aspera* L.	H	Latjiri, Lichkuri; M
Chenopodiaceae	*Chenopodium ambrosiodes* L.	H	-
Polygonaceae	*Rumex hastatus* D. Don	H	Kilmora; M
	Fagopyrum esculentum Moench	H	Kotu; Mu
Lauraceae	*Cinnamomum tamala* (Buch.-Ham.) T. Nees ex C.H. Eberm.*	T	Dalchini, Tejpat; M
	Machilus odoratissima Nees	T	Kaula; Fd
Proteaceae	*Grevillea robusta* A. Cunn.	T	Gwiral; Mu
Santalaceae	*Osyris arborea* Wall.	S	Bakroliya; M
Euphorbiaceae	*Andrachne cordifolia* Muell.-Arg.	S	Bhatla; M
	Bridelia retusa Spreng	T	Gauli; Fd, M
	Jatropha curcas L.*	ST	Pahari arand; M, Fw
	Ricinus communis L.	S	Arand; M
	Euphorbia helioscopia L.	H	Dudhya; M
	Emblica officinalis Gaertn.	T	Aonla; M, Mu
	Flueggea microcarpa Bl.	S	-
Urticaceae	*Boehmeria platyphylla* D. Don	S	Khagsa; M, Fd
	Debregeasia hypoleuca (Steud.) Wedd.	ST	Syanru; Fd, M
	Girardinia heterophylla Decne	H	Jhir kandali, M
	Pilea scripta (Buch.-Ham. ex D. Don) Wedd.	H	Chailu
	Urtica dioica L.	H	Kandali; M
Myricaceae	*Myrica nagi* Thunb.*	T	Kafal; Mu
Ulmaceae	*Celtis australis* L.	T	Kharik; Fd, M, Mu
Cannabaceae	*Cannabis sativa* L.	H	Bhangla; M
Moraceae	*Ficus roxburghii* Wall. ex Steud.	T	Timla; Fd
	Ficus rumphii Bl.*	T	Kobar; Fd
	Morus alba L.*	T	Tutri; Fd, Fw
Corylaceae	*Carpinus viminea* Wall. ex Lindl.	T	Putli; Fd, Mu
Fagaceae	*Quercus leucotrichophora* A. Camus	T	Banj; Fd, Fw
Monocotyledons			
Orchidaceae	*Goodyera procera* Hook.	H	M
	Habenaria pectinata D. Don	H	-
	Nervilia aragoana Gaud.	H	-
Zingiberaceae	*Zingiber officinale* Roscoe	H	Adrak; M
Haemodoraceae	*Ophiopogon intermedius* D. Don.	H	-
Amaryllidaceae	*Allium cepa* L.	H	Paiz; M, Mu
	Allium sativum L.	H	Lehsun; M, Mu
Agavaceae	*Agave cantula* Roxb.	S	Rambans

Table 2: Species reported from the Kunjapuri Siddhapeeth as per Bentham and Hooker Classification (*contd.*)

Family	Species	Habit	Local names; Uses
Dioscoreaceae	*Dioscorea belophylla* Voigt	C	Tairu, Tarur; M, Fd
Liliaceae	*Asparagus racemosus* Willd.	S	Jhiran, Satawar; M
Smilacaceae	*Smilax glaucophylla* Klotzsch	C	Kukurdara; Fd, M
Araceae	*Arisaema flavum* Schott	H	Meen; M
	Colocasia esculenta Schott	H	Pindalu; Mu
	Sauromatum guttatum Schott	H	Bhasmakhand; M
Cyperaceae	*Carex setigera* D. Don	Sg	-
	Carex filicina Nees	Sg	-
	Carex wallichiana Presc.	Sg	-
	Cyperus iria L.	Sg	-
	Cyperus niveus Retz.	Sg	Murya-ghas
	Eriophorum comosum Nees	Sg	Babula
	Kobresia sp. Willd.	Sg	-
Gramineae (Poaceae)	*Apluda mutica* L.	G	Tashila; Fd
	Arthraxon lancifolius Hochst.	G	Kangulya; Fd
	Arthraxon prionodes (Steud.) Dandy	G	Fd
	Arundinella nepalensis Trin.	G	Fd
	Arundinaria falcata Nees	G	Ringal; Mu
	Bothriochloa bladhii (Retz.) S.T. Blake	G	Fd
	Capillipedium parviflorum (R. Br.) Stapf	G	Nigalia ghas; Fd
	Chrysopogon serrulatus Trin.	G	Golda; Fd
	Cymbopogon distans (Nees ex Steud.) Will. Watson	G	Dubda; Fd
	Cynodon dactylon (L.) Pers.	G	Dubla; M
	Digitaria setigera Roth	G	Fd
	Dendrocalamus strictus Nees	G	Bans; Mu
	Erianthus filifolius Nees ex Steud.	G	-
	Eulaliopsis binata (Retz.) C.E. Hubb.	G	Sabai ghas; Fd, Mu
	Heteropogon melanocarpus Benth.	G	-
	Neyraudia arundinacea (L.) Henrard	G	Bichhroo; Fd
	Oplismenus compositus (L.) P. Beauv.	G	Gharia ghas; Fd
	Paspalidium flavidum (Retz.) A. Camus	G	Fd
	Pennisetum orientale Rich.	G	Fd
	Setaria glauca P. Beauv.	G	Ban kauni; Fd
	Setaria homonyma Chiov.	G	-
	Sporobolus diander P. Beauv.	G	Sitya; Fd, Mu
GYMNOSPERMS			
Cupressaceae	*Cupressus torulosa* D. Don*	T	Surayi, Luiri; Mu
	Thuja orientalis L.*	T	Morpankhi; Mu

*Planted Species

Abbreviations used are H = Herb; S = Shrub; US = Under Shrub; C = Climber; T = Tree; ST = Small Tree; G = Graminoid; Sg = Sedge; P = Parasite; Fw = Fuel-wood; Fd = Fodder; Tm = Timber; M = Medicinal and Mu = Multi-use

household and agricultural purposes. Uses of 32 species were not known.

CONCLUSION

The sacred forest of Kunjapuri Siddhapeeth is rich in plant diversity. The role of sacred groves in the maintenance of biodiversity is significant, as discussed earlier. However, the area under sacred forest is depleting due to the interplay of an array of factors. Sacred forests were originally maintained in the form of untouched ecosystems dedicated to a deity, but are in recent years, looked up on as an important source of revenue, and hence, they cannot be expected to survive on the basis of spiritual beliefs. Therefore, there is an urgent need to implement rural participatory management practices with the help of the village community, temple authorities, and forest committees to conserve such forest patches. The area adjacent to the grove could be developed as a supply reserve forest to cater the needs of the locals, to reduce pressures on the sacred grove. Generation of awareness and participatory management are the key aspects for conservation of sacred groves, which are the repositories of biological diversity of the region.

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NEW DESCRIPTION

A NEW SPECIES OF *NOTASPIDIELLA* BOUČEK (HYMENOPTERA: CHALCIDIDAE) WITH A KEY TO SPECIES AND NOTES ON KNOWN SPECIES

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The genus *Notaspidiella* Bouček (Hymenoptera: Chalcididae) is briefly reviewed with description of a new species *N. shyamagatra* Narendran sp. nov. from India. A key to species of *Notaspidiella* is also provided. The genus *Neoirichohalticella* Narendran is downgraded as a subgenus of *Notaspidiella* Bouček.

Key words: *Notaspidiella*, Chalcidoidea, Hymenoptera, Key, new species, review

INTRODUCTION

The genus *Notaspidiella* was erected by Bouček (1988) based on the type species *Irichohalticella tirathabae* Ferrière. The genus consists of three species, namely *N. tirathabae* (Ferrière) (1933) from Java, *N. frater* (Masi 1917) from Seychelles, and *N. clavata* Narendran and Konishi (2004) from Thailand. In this paper, a new species *N. shyamagatra* Narendran is described and the species *Neoirichohalticella sringeriensis* Narendran (Narendran *et al.* 2006) is transferred to *Notaspidiella* Bouček (comb. nov.). Diagnoses of all the known species and a key to species are provided. Bouček (1988) stated that the genus *Notaspidiella* is known from Seychelles, Mauritius, Sarawak, and east Malaysia. The holotype of the new species described in this paper is deposited in the Regional Centre of Zoological Survey of India, Kozhikode (ZSIK).

Abbreviations used: AOL = distance between anterior ocellus and a posterior ocellus; F1 to F7 = funicular segments 1 to 7; L = length; MS = Malar space; MV= Marginal vein; OOL = minimum distance between eye and posterior ocellus; POL = minimum distance between posterior ocelli; T1 to T6 = tergites of gaster 1 to 6; W= width.

Acronyms of depositories: BMNH = The Natural History Museum, London; ZSIC = Zoological Survey of India, Kolkata; ZSIK = The Western Ghats Regional Centre of Zoological Survey of India, Kozhikode.

Notaspidiella Bouček

Notaspidiella Bouček, 1988: 56. Type species *Irichohalticella tirathabae* Ferrière (1933: 87).

Neoirichohalticella Narendran 2006 (Narendran *et al.* 2006). (Type species *Neoirichohalticella sringeriensis* Narendran). Downgraded here to subgenus: syn. nov. and stat. nov.

Diagnosis: Head with antennae inserted close to mouth; clypeus usually turned down ventrally (Fig. 4) [in *N. sringeriensis* produced forward (Fig. 22)]; scutellum dorsally almost flat, its apex distinctly produced posteriorly (Figs 11 and 12) jutting over propodeum; propodeum horizontal; gaster broadly sessile; T1 and T2 fused in nominal subgenus *Notaspidiella* and not fused in subgenus *Neoirichohalticella* Narendran (stat. nov.). T1 with anterior cross carina and behind it with at least 2 submedian carinae and 2 sublateral carinae or with several carinae or occasionally with additional striae; apex of gaster in female acuminate; in male T6 with strong dorsal tooth or tubercle (Bouček 1988).

Hosts: *N. tirathabae* is parasitic on *Tirathaba rufivena* Walker (Lepidoptera: Pyralidae) in Java (Ferrière 1933). *N. clavata* is recorded from *Sitophilus* sp. (Coleoptera) from Thailand (Konishi *et al.* 2004).

Distribution: Seychelles, Thailand, Mauritius, Malaysia (Bouček 1988; Konishi *et al.* 2004), India (present record).

Remarks: As a result of discovery of more variation in the characters of *Notaspidiella*, the genus *Neoirichohalticella* Narendran must be considered as a subgenus of *Notaspidiella* Bouček. Hence, the genus *Neoirichohalticella* Narendran (Narendran *et al.* 2006) is hereby downgraded (stat. nov.) as a subgenus of *Notaspidiella* Bouček.

The genus *Notaspidiella* comes very close to *Irichohalticella* Cameron (1912) in having T1 with anterior cross carina and behind it with at least 2–4, or rarely more longitudinal carinae. However, it differs from *Irichohalticella* in having apex of scutellum angulate and produced over the propodeum, whereas in *Irichohalticella* the scutellum has a rounded apex. It is also close to *Notaspidium* (Dalla Torre 1897), but differs in having hind femur with long comb of teeth starting from a subbasal tooth, whereas in *Notaspidium* the comb of teeth starts from the middle with larger tooth.

It resembles *Nearretocera* Girault (1913) in having the comb of hind femur long, beginning from proximal tooth situated in about basal third of ventral edge but differs from *Nearretocera* in having: MV short and situated away from anterior margin (Figs 8, 12), in *Nearretocera* MV long [Fig. 52 of Bouček (1988)] and virtually on the margin. Besides this, the forewing is without infuscate band (in *Nearretocera* forewing with double bands); and apex of scutellum produced over the propodeum as a horn (in *Nearretocera* apex of scutellum is not produced over propodeum as a horn or projection).

It resembles *Nipponochalcidia* Habu (1976) in having T1 anteriorly with raised cross-carina and behind it longitudinal carinae or striae, but *Nipponochalcidia* differs from *Notaspidiella* in having apex of scutellum not produced over propodeum and MV almost close to anterior margin of wing, almost touching it; and propodeum with distinct submedian and sublateral carinae.

KEY TO SPECIES OF *NOTASPIDIELLA* BOUČEK

(Based on females)

1. T1 distinctly delimited or separately marked (Figs 9, 21), (liguliform), not reaching middle of gaster. Subgenus *Neoirichohalticella* Narendran (stat. nov.) 2

— T1 fused with T2 (Fig. 19) (not liguliform). Nominal subgenus *Notaspidiella* Bouček 4

2. Clypeus and mandibles produced forward (Fig. 22); antenna reddish-yellow with median part of funicle pale blackish (Fig. 21); width of lower margin of head 0.51x width of head in anterior view. India .... *N. sringeriensis* (Narendran)

— Clypeus and mandibles not produced forward; antenna (Fig. 4) black with base and apex of scape and clava dark brown with reddish tinge; width of lower margin of head narrower than in alternate (Figs 2, 14). India 3

3. T1 with dense striae besides longitudinal carinae (Figs 9, 10); T2 sparsely pitted (Figs 9, 10); propodeum without longitudinal carinae; antenna (Fig. 4) black with base and apex of scape and clava dark brown with reddish tinge. India .... *N. shyamagatra* Narendran, sp. nov.

— T1 with 8 to 10 longitudinal carinae, but not densely striate as above; T2 with large close pits (Fig. 20); propodeum with submedian and sublateral carinae; antenna mostly blackish with scape and pedicel reddish-yellow. Seychelles .... *N. frater* (Masi)

4. Antennal clava undivided; MS almost as long as eye height; metapleuron strongly reticulate; metasoma as long as mesosoma; projected apex of scutellum 0.2x remaining length of scutellum. Java, Sri Lanka, Philippines, Sumatra .... *N. tirathabae* (Ferrière).

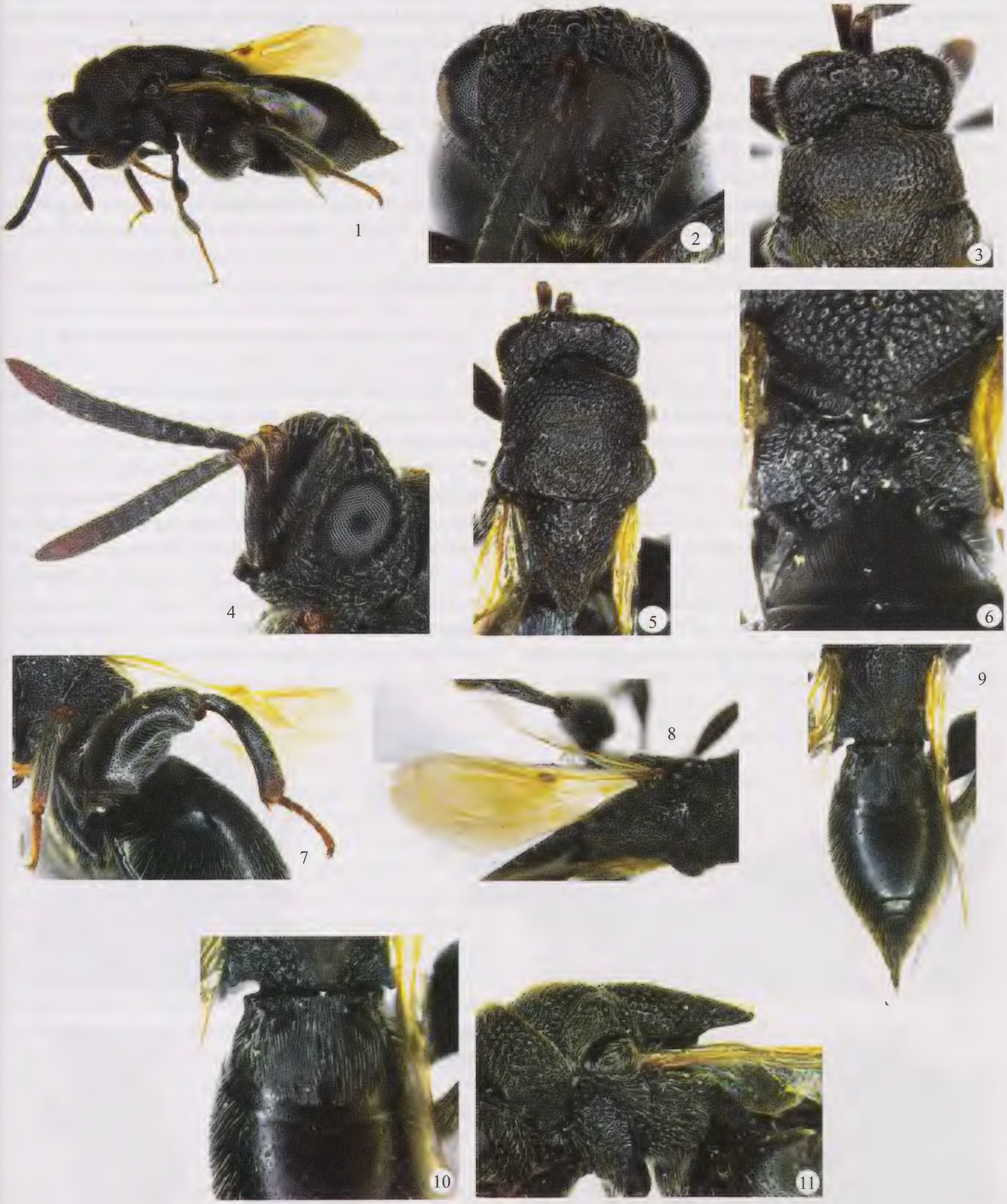
— Clava distinctly three segmented; MS (Fig. 12) shorter than height of eye (7:11); metapleuron densely pitted and not reticulate; metasoma longer than mesosoma; projected part of scutellum 0.31x remaining length of scutellum. Thailand .... *N. clavata* Narendran & Konishi

1. *Notaspidiella* (*Neoirichohalticella*) *shyamagatra* Narendran, sp. nov. (Figs 1–11)

Female (holotype): Length 4.08 mm. Body black except as follows: base and apex of scape and clava dark brown with reddish tinge; fore and mid trochanters, apices of fore and mid femora, bases and apices of fore and mid tibiae reddish brown; all tarsi brown; wings hyaline with yellowish tinge, veins brown; pubescence of wings brown; pubescence of body silvery.

Head: Head width (Fig. 2), in anterior view, 1.21x its height (104:86); head width (Fig. 3) in dorsal view, 2.3x its length (103:45); MS 0.7x eye height in profile (28:39); eye length equal to MS (28:28); POL 1.93x OOL (27:14); AOL shorter than OOL (12:14); with close umbilicate pits, interstices carinate; scrobe reaching anterior ocellus, with 17–21 cross carinae; interantennal projection protruding anteriorly (Fig. 4); preorbital carina reaching vertex but not curving behind anterior ocellus. Antennal formula 11173; inserted far below lower ocular line (Fig. 4); length between apex of clava and apex of scape longer than head width in dorsal view (113: 103); relative L:W of antennal segments: scape = 57:11; pedicel = 18:9; anellus = 7:9; F1 = 5:10; F2 = 8:11; F3 = 10:11; F4 = 11:12; F5 = 11:12; F6 = 11:12; F7 = 11:12; clava = 26:12.

Mesosoma: Mesosoma (Fig. 5) 3.5x as long as wide (185:53); pronotum 1.73x as wide as its length (104:60), with close umbilicate pits, interstices carinate; mesoscutum with similar sculpture to pronotum, but interstices ecarinate and rugulose in posterior median part and in middle area of scapula; scutellum 1.1x as long as wide, with close umbilicate pits, interstices ecarinate, space between pits shorter than half diameter of a pit; apex of scutellum projecting over propodeum (Fig. 11); tegula densely pubescent; propodeum horizontal, coarsely and irregularly pitted (Fig. 6); width of propodeum 1.93x its length (77:40); mesepisternum concave with pits and striae; mesepimeron (Fig. 1) closely pitted with interstices carinate. Forewing (Fig. 8) 2.7x as long as wide (250:92), pilose which becomes sparse basally, with two white streaks (Fig. 8); MV distinctly removed from anterior wing



Figs 1–11: *Notaspidiella shyamagatra* Narendran sp. nov. Female: 1. Body profile; 2. Head anterior view; 3. Head and pronotum dorsal view; 4. Antenna and head side view; 5. Mesosoma dorsal view; 6. Propodeum; 7. Hind leg; 8. Forewing; 9. Gaster dorsal view; 10. T1 and part of T2 dorsal view; 11. Scutellum side view

margin. Hind coxa 2.5x as long as width (42:17), dorsal side smooth, remaining part with micropits and pubescence; hind femur length 2.2x its width (107:48), with dense minute pits (Fig. 7), interstices smooth and shiny, lower edge with subbasal sharp tooth behind which dense comb of teeth slightly curves before ascending on subapical lobe; length of subbasal large tooth 0.33x width of hind tibia. Hind tibia 5.4x as long as wide (98:18), apex with 2 spurs, each spur as long as hind metatarsus. Hind metatarsus equal in size to second tarsal segment, third tarsal segment shorter than second but equal to fourth; fifth tarsal segment 1.9x as long as fourth; each claw shorter than fourth tarsal segment (8:9).

Metasoma: Gaster broadly sessile (Fig. 9); T1 not fused to T2, with dense longitudinal striae and carinae (Figs 9, 10), length of striated area 0.84x length of T1 (52:62). T2 longer than T1 (112:62). Relative L:W of tergites : T1 = 62:85; T2 = 112:108; T3 = 14:65; T4 = 12:54; T5 = 10:41; T6 = 14:32; epipygium = 13:18; ovipositor sheath = 17:9.

Male: Unknown.

Host: Unknown.

Distribution: INDIA: Kerala.

Material examined: Holotype, female: INDIA: Kerala, Kannur district, Aralam Wildlife Sanctuary [11° 54'–11° 9' N and 75° 47'–75° 57' E], 12.x.2012, malaise trap set by Abilash, Nikhil, and Minu (ZSIK).

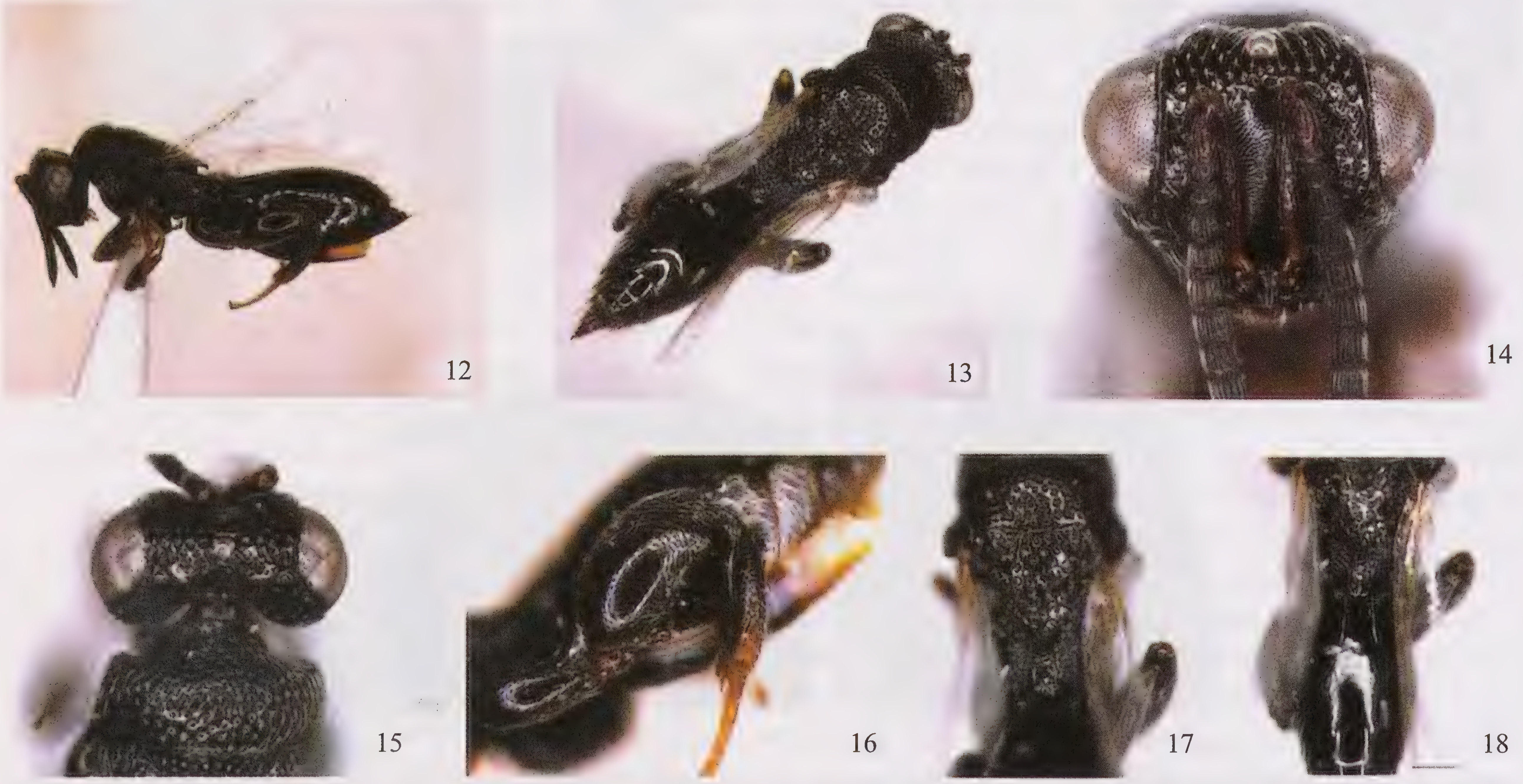
Etymology: The species name 'shyamagatra' is taken from Sanskrit meaning black body.

Remarks: This is a unique species with T1 delimited and with strong striae and carinae (Figs 9, 10) by which this species can be separated from all other known species of *Notaspidiella. Irichohalticella pilosella* Cameron (1912), the type (Male: No.5.300 B.M.) of which one of us (TCN) examined in 1980 at BMNH, shows close resemblance to this species in having similar type of striae and carinae on base of gaster but differs from *N. shyamagatra* in having T1 fused with T2 (in *N. shyamagatra* T1 not fused); apex of scutellum rounded and not jutting out over propodeum (generic difference) (in *N. shyamagatra* apex of scutellum produced posteriorly and jutting over propodeum (generic difference).

2. *Notaspidiella* (*Notaspidiella*) *clavata* Narendran & Konishi (Figs 12–18)

Notaspidiella clavata Narendran & Konishi, in Konishi *et al.*, 2004: 34. Holotype Female, Thailand (ZSIC) (examined).

Diagnosis: Female: Length 2.65–3.1mm. Black except the following: base and apex of scape brown; all trochanters, bases and apices of fore and mid femora and tibiae, apical dorso-lateral part of hind tibia dark yellowish-brown with a slight reddish tinge; apical part of hypopygium yellowish brown; all tarsi yellowish brown. Scrobe (Fig. 14) cross reticulate; POL 3–4x OOL (Fig. 15); MS 0.5–6x eye height in profile (Fig. 12). Pedicel 2.25x as long as F1. Mesosoma (Fig. 17) with distinct close setigerous pits, interstices smooth



Figs 12–18: *Notaspidiella clavata* Narendran & Lambert: Female: 12. Body profile; 13. Dorsal view of body; 14. Head anterior view; 15. Head and pronotum dorsal view; 16. Hind leg; 17. Scutellum and propodeum dorsal view; 18. Fused T1 and T2 dorsal view

and shiny except an anterior marginal area of mesoscutum, where pits are relatively smaller (Fig. 13) and interstices rugulose; apex of scutellum narrow and acuminate, projecting over propodeum (Figs 13, 17); propodeum (Fig. 18) with submedian and sublateral carinae; Metasoma broadly sessile, approximately 1.1x length of mesosoma; T1 and T2 fused (Fig. 18), with 2 submedian and 2 lateral carinae; all carinae separated from each other with deep depression at base; hypopygium exceeding well beyond middle of Metasoma.

Male: Length 2.05 mm. Similar to female. T6 with strong dorsal tooth directed posteriorly.

Host: Collected from *Sitophilus* sp. in rice storage. Probably secondary parasite (Konishi *et al.* 2004).

Distribution: Thailand.

Remarks: This species approaches *N. tirathabae* (Ferrière) in general appearance but differs from *N. tirathabae* in having: i. clava distinctly 3-segmented (clava undivided in *N. tirathabae*); ii. MS 0.5–0.6x height of eye in profile (in *N. tirathabae* MS almost as long as eye height); iii. metapleuron closely pitted (Fig. 13) (in *N. tirathabae* metapleuron strongly reticulate); and iv. metasoma distinctly longer than mesosoma (in *N. tirathabae* metasoma as long as mesosoma).

3. *Notaspidiella (Notaspidiella) tirathabae* (Ferrière)

Irichohalticella tirathabae Ferrière, 1933: 87. Holotype Female (BMNH No.5-301) Java (examined) *Notaspidiella tirathabae* (Ferrière). Bouček, 1988: 87.

Diagnosis: Female: Length 2.6–2.8 mm. Black except the following: apex of fore femur, apices of all tibiae, all tarsi, brownish; remaining parts of legs blackish brown. MS almost as long as eye height; OOL shorter than diameter of a posterior ocellus; pedicel 1.75x as long as F1; F2 a little longer than F2 (4:3.5). F4, F5, F6, and F7 of equal length; F1 to F7 gradually widening; clava 3x as long as F7 and longer than combined length of F6 and F7 (12:8). Mesosoma 1.6x as long as its width; mesoscutum length 0.71x length of scutellum; scutellum length including apical projection 1.14x its width, apical projection length 0.2x of remaining length of scutellum; apical projection of scutellum jutting over metanotum and slightly over base of propodeum; propodeum with submedian and sublateral carinae, horizontal with weak cross carinae; propleuron and mesopleuron rugulose; metapleuron strongly reticulate. Metasoma as long as mesosoma, 2.4x as long as its width; T1 fused with T2, with 2 submedian and 2 lateral carinae, all carinae separated by depressions at base; length of a submedian carina 0.46x length of fused T1and T2; one cercal seta longer than next longer seta on each side.

Male: Length 2.2 mm. Similar to female except pedicel not longer than its width; clava as long as F6 and F7 combined.

Host: Recorded breeding on cocoons of *Apanteles tirathabae* Walker (Hymenoptera: Braconidae), from pupa of *Tirathaba rufivena* Walker (Lepidoptera: Pyralidae).

Distribution: Sri Lanka, Philippines, and Sumatra (Bouček 1988; Ferrière 1933; Noyes 2013).

Remarks: This species comes near *N. clavata* in general appearance but differs from it in having: i. Clava unsegmented (in *N. clavata* clava 3 segmented); ii. MS almost as long as eye height in profile (in *N. clavata* MS distinctly shorter (7:11) than height of eye; iii. Metasoma as long as mesosoma (in *N. clavata* metasoma longer than mesosoma); iv. projected apex of scutellum 0.2x remaining length of scutellum (in *N. clavata* projected part of scutellum 0.31x remaining length of scutellum).

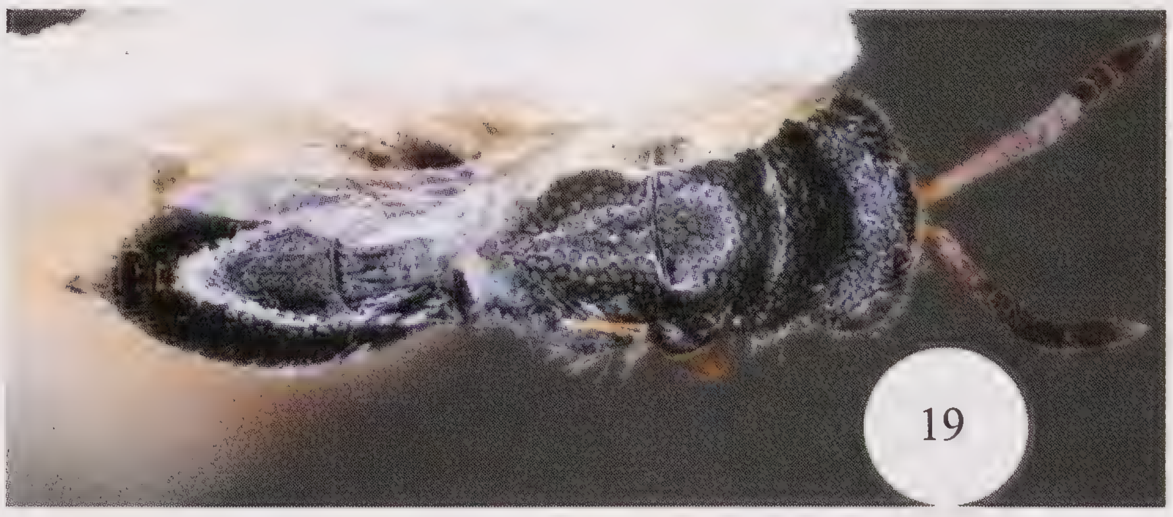
4. *Notaspidiella (Neoirichohalticella) frater* (Masi), comb. nov. (Figs 19, 20)

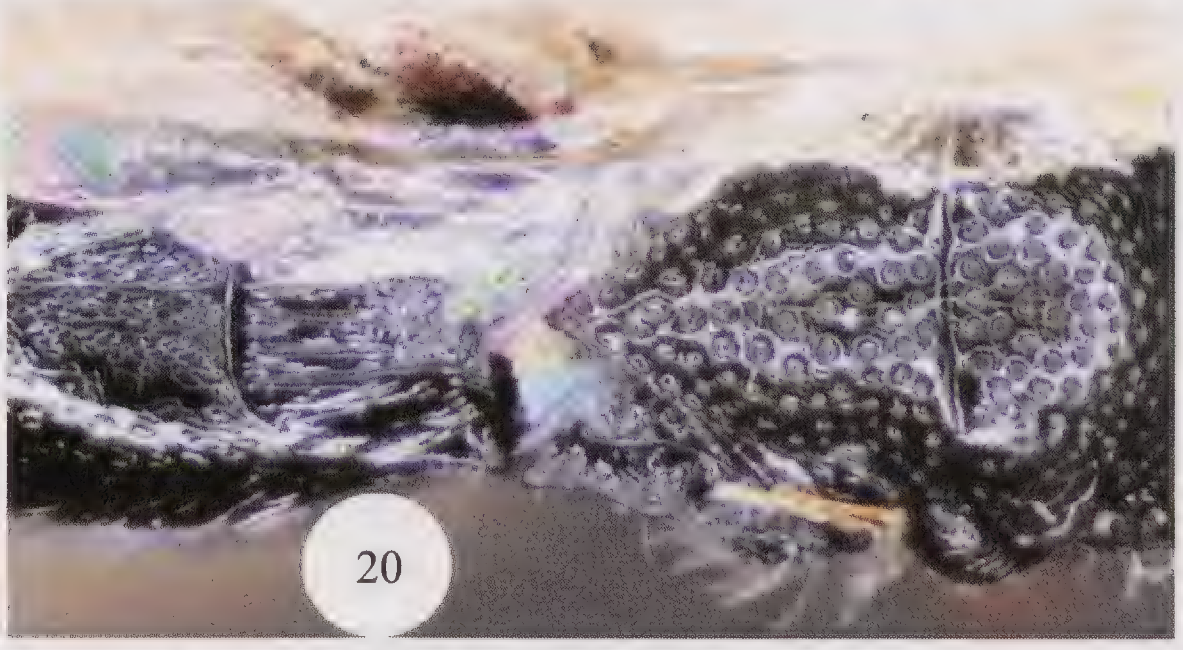
Hybothorax frater Masi, 1917, 1917: 134. Holotype Female, Seychelles (BMNH) (examined) *Notaspidiella frater* (Masi): Bouček, 1988: 57.

Diagnosis: Female: Length 2.6 mm. Black except for the following: eyes chestnut brown (Masi 1917), scape, pedicel, fore and mid legs (except coxae), base and apex of femora, apex of hind tibia and entire tarsi reddish yellow. Head not wider than mesosoma (19:20) (excluding tegula); scrobe cross striate with upper part minutely strigulose; occiput with tibia. Metasoma as long as mesosoma; T1 distinctly delimited with 10 longitudinal carinae; T2 distinctly pitted with large close pits (Figs 19, 20).

Host: Unknown

Distribution: Seychelles.





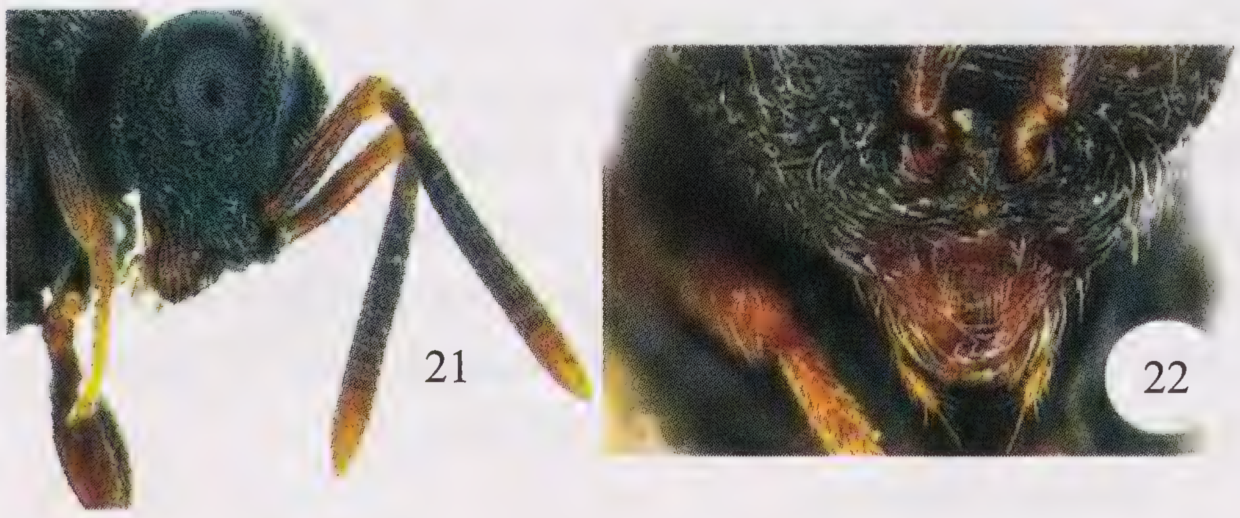
Figs 19–20: *Notaspidiella frater* (Masi) Female:
19. Body dorsal view; 20. Scutellum, T1 and T2.

Remarks: This species comes close to *Notaspidiella shyamagatra* Narendran, sp. nov. in having T1 delimited, apex of scutellum similar, and sculpture on mesoscutum similar. However, *N. frater* differs from *N. shyamagatra* in having: i. T1 not striate but carinate with 10 longitudinal carinae (in *N. shyamagatra* T1 striate and carinate); ii. T2 with large close pits (Figs 20, 21) (in *N. shyamagatra* T2 weakly and sparsely pitted as in Fig. 9), and iii. length of large subbasal tooth of hind femur 0.6x width of hind tibia (in *N. shyamagatra* subbasal tooth of hind femur 0.33x width of hind tibia).

5. *Notaspidiella (Neoirichohalticella) sringeriensis* (Narendran) comb. nov., stat. nov. (Figs 21, 22)

Neoirichohalticella sringeriensis Narendran 2006 (in Narendran *et al.* 2006), Holotype female, India (ZSIK) (examined).

Diagnosis: Length 4 mm. Body black except as follows: Clava pale brownish yellow; pedicel pale reddish brown; scape reddish brown with base and apex pale brownish yellow; radicula pale brownish yellow; fore and mid trochanters, apices of fore and mid femora, bases and apices of fore and mid tibiae brownish yellow; apex of hind tibia pale brown; all tarsi yellow. Head width in anterior view 1.12x its height (84:75); head width in dorsal view 2x its length (8:4); POL 2x OOL (20:10); AOL 2.5x OOL (25:10); MS 0.7x eye height (27:41); eye length 0.96x eye height (27:28); clypeus and mandibles projecting forward (Fig. 21); antenna as in Fig. 21. Mesosoma tegula pubescent; sculpture on mesoscutum, and scutellum projecting over propodeum; propodeum with irregular pits; plicae and submedian carinae weakly distinct. T1 with dense distinct longitudinal carinae (not striate).



Figs 21–22: *Notaspidiella sringeriensis* (Narendran) Female: 21. Head side view; 22. Head anterior view

Male: Unknown.

Host: Unknown.

Distribution: INDIA: Karnataka (Sringeri).

Material examined: Holotype.

Remarks: This species resembles *N. shyamagatra* in general appearance but differs from it in having: i. Clypeus and mandibles projecting forward (Fig. 22) (in *N. shyamagatra* clypeus and mandibles hidden beneath and not projecting; ii. T1 more carinate and not striate (in *N. shyamagatra* T1 more striate than carinate).

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MISCELLANEOUS NOTES

1. FIRST PHOTOGRAPHIC RECORD OF THE INDIAN MOUSE DEER *MOSCHIOLA INDICA* IN KANHA TIGER RESERVE, CONFIRMING ITS OCCURRENCE IN CENTRAL INDIA

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Mouse deer are poorly known ungulates due to their nocturnal, rare, and elusive nature. They are taxonomically classified under Family Tragulidae, an ancient group of primitive ruminants, with history dating back to the Miocene (Gentry and Hooker 1988; Groves and Meijaard 2005; Webb and Taylor 1980). There are two extant genera, *Moschiola* and *Tragulus*, which occur in the South and Southeast Asian region (Meijaard and Groves 2004). Recent taxonomic revision by Groves and Meijaard (2005) has separated the Indian species of mouse deer as *Moschiola indica.* Based on phylogenetic species concept, it has been segregated from *Moschiola memina*, which is now restricted to parts of Sri Lanka.

The Indian Mouse Deer *Moschiola indica* is one of the smallest ungulate species. It is found in tropical moist deciduous and evergreen forests of peninsular India. Its distribution is still uncertain due to poor sighting records. The present distribution, based largely on anecdotal observations by authors, or through interaction with forest officials, is said to be Tamil Nadu and Kerala in the south, and north to at least 24° N, i.e., southernmost parts of Rajasthan, central Madhya Pradesh, Jharkhand, and Odisha (formerly Orissa) (Prater 1971). Champion (1929) strongly doubted its occurrence in northern India and Nepal, and originated a common view on its northern limit being at about 24° N. However, Mitchell and Punzo (1976) later recorded its occurrence in Nepal by direct observation of a live specimen in a Sal *Shorea robusta* patch in Banke district, and obtained a partial skeleton from a hunter. However, this record was overlooked by Groves and Meijaard (2005) in their paper on the species.

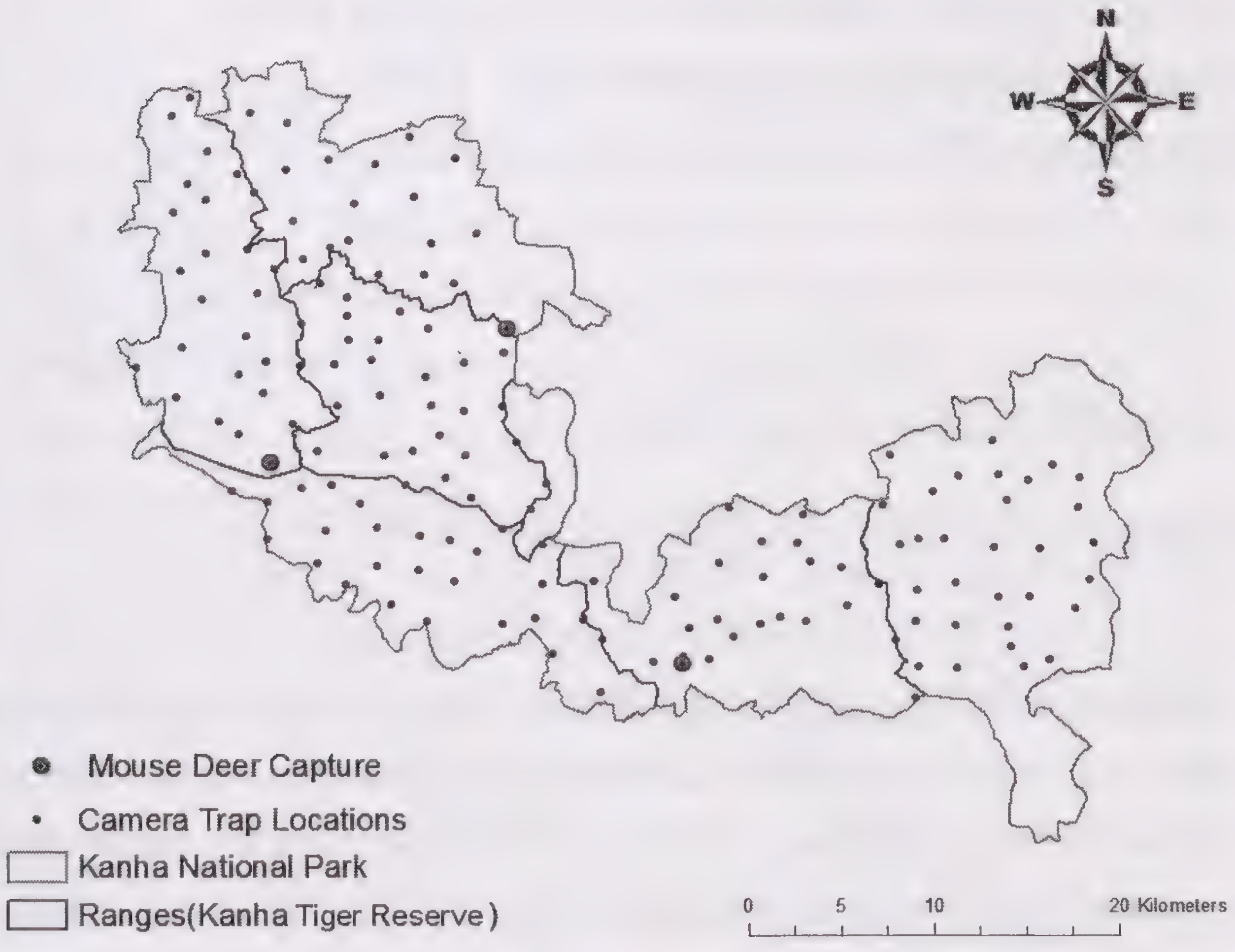

Fig. 1: Camera trap locations at study site

Recent reliable information to confirm its presence in central India is lacking, where it has not been photographed for the last 100 years. The last record and photograph of the species was taken by Brook (1906) in January 1905 in Raipur district of the Central Provinces, which now lies in Chhattisgarh state. However, Champion (1929) and Krishnan (1972) had confirmed its presence in Mandla district, Madhya Pradesh – through information generated by interaction with the locals and forest guards. Ghose and Bhattacharya (1995) made an inventory of fauna of Kanha Tiger Reserve, but gave the status of Indian Mouse Deer as unknown, with no evidence recorded. During a survey in Kanha, in 2010, we gathered that forest and other locals had never seen the Indian Mouse Deer *Moschiola indica* in and around Kanha Tiger Reserve. However, subsequently on camera-trapping from 2010 to 2013 we obtained four photographs of the species in four ranges of Kanha Tiger Reserve.

We used 140 camera traps with an average trap distance of 1.8 km in the Tiger Reserve, covering all the ranges, a total of 700 sq. km (Fig. 1). The first photograph (ed.: photographic evidence provided) was obtained in the Dhawajhandi, Kisli range (22° 14' 3.8" N; 80° 34' 57.4" E), on June 29, 2010, but the photograph was not clear. After that, we got clear photographs on March 12, 2012, (Fig. 2) in Deotalai, Kanha range (22° 17' 58.0" N; 80° 42' 21.4" E), and again on January 19, 2012 (ed.: photographic evidence provided) in Pongapani, Bhaisanghat range (22° 8' 51.14" N; 80° 45' 22.17" E). These records confirm the presence of the Indian Mouse Deer in Kanha Tiger Reserve, and suggest the potential of the moist deciduous forest of Central India as a stronghold for the species and its habitat if there is good protection.

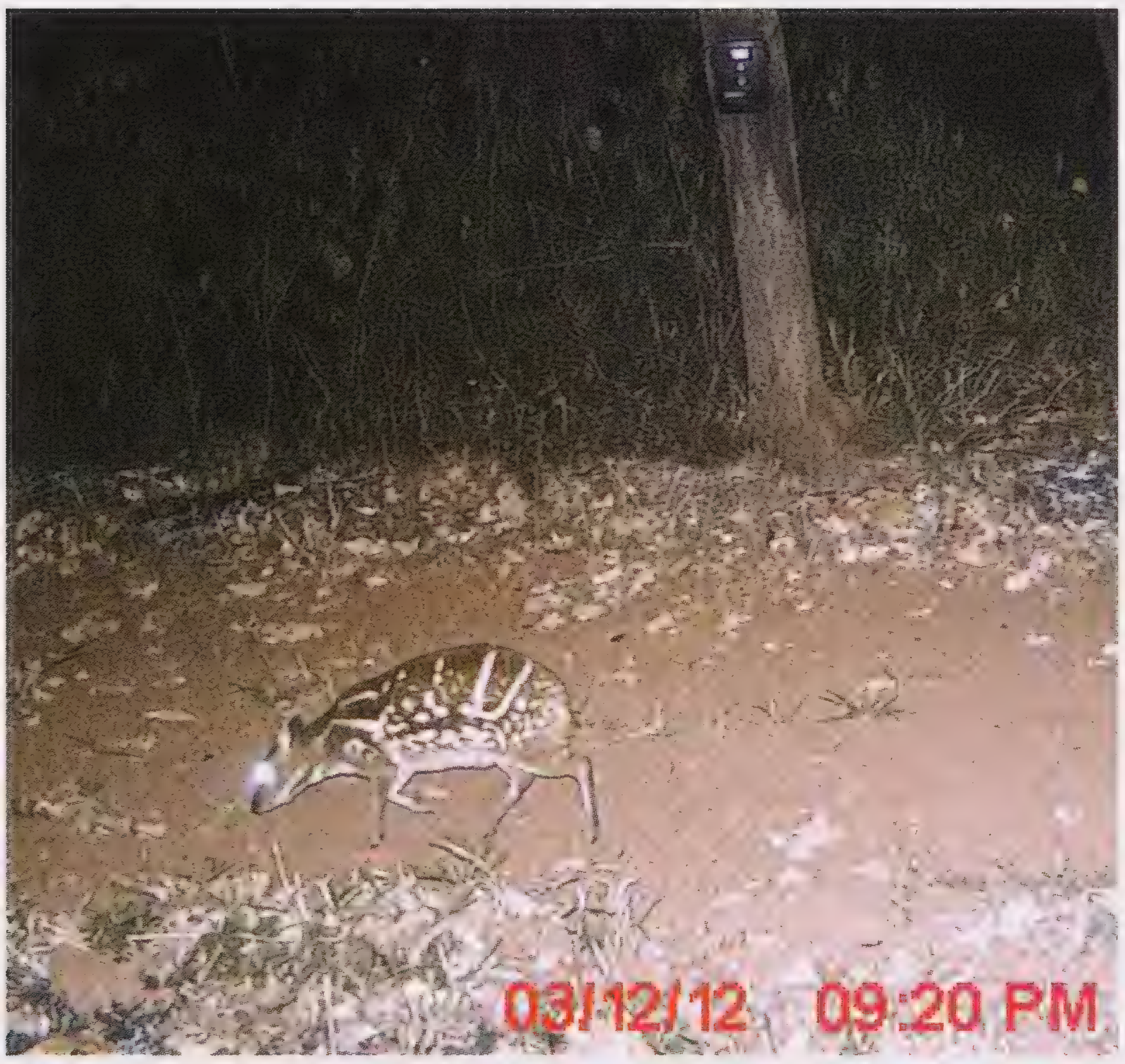

Fig. 2: *Moschiola indica* photographed on March 12, 2012, in Deotalai, Kanha range

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2. STATUS OF IRRAWADDY DOLPHIN *ORCAELLA BREVIROSTRIS* GRAY, 1866 AND GANGES RIVER DOLPHIN *PLATANISTA GANGETICA* ROXBURGH, 1801 IN THE WATER CHANNELS OF SUNDARBAN TIGER RESERVE, INDIA

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The Sundarbans are the world's largest mangrove forest situated in the delta of the Ganga-Brahmaputra-Meghna river systems (Chakrabarti 1992). They comprise innumerable islands with a huge network of small rivers and channels. Around 38% of the area of Sundarbans lies in India and the rest in Bangladesh (Mitra 2000). There are historical reports of the presence of Ganges River Dolphin (*Platanista gangetica* Roxburgh, 1801) and Irrawaddy Dolphin (*Orcaella brevirostris* Gray, 1866) in the water channels of the Indian Sundarbans (Anderson 1879; Jones 1982), but for the Indian Sundarbans, there has been no detailed study on the status, distribution or abundance of these cetaceans. The situation is somewhat different for Bangladesh Sundarbans, as the distributional patterns and abundance estimates for these two cetacean species are available for the entire delta (Smith *et al.* 2006).

In February 2010, a study was initiated in the Sundarban Tiger Reserve (STR) of India to estimate its tiger population. As a part of this exercise, boat transects were carried out to estimate the animal sign encounter rates along the banks of the forested islands from February to mid-May 2010. Sundarban Tiger Reserve is divided into a buffer zone and core zone. The buffer zone comprises two ranges, namely the Sajnekhali Wildlife Sanctuary and the Bashirhat Range. The core zone comprises the National Park, which also consists of two ranges, namely National Park West and National Park East. Together the Sajnekhali range and the National Park West range comprise the western part of STR. Surveys were carried out only in the western part of STR due to logistic constraints. During the transect surveys, dolphin sightings were also recorded. The boat transects were conducted during the early morning, late afternoon, and evening hours, during which the speed of the mechanised boat was maintained at around 4.5 km/hr, and at any time there were two observers looking out for signs. A total of 237.8 km of boat transects were done: 117.3 km in Sajnekhali Wildlife Sanctuary and 120.5 km in National Park West range.

During the surveys, eight groups of Irrawaddy Dolphin totalling 14 individuals were sighted and there was only one sighting of the Ganges River Dolphin, a single individual. Among the Irrawaddy Dolphin groups sighted, three were sighted in Sajnekhali Range (Dattar beat) and five in National Park West range (four in Netidhopani beat and one in Haldibari beat). The single sighting of a lone Ganges River Dolphin was in the Matla river area that adjoins Netidhopani beat. During the survey, a group of three dolphins was also sighted which could not be identified. For the Irrawaddy Dolphin, the mean group size was 1.75 (SE = 0.25, range = 1–3) and the encounter rate was 0.06 dolphins/linear kilometre (SE = 0.02). Since these transects were concerned with tiger signs (Signs of Tiger and its prey species) on the mud banks of the islands and were not specifically designed for a cetacean survey, it is possible that some of the cetacean surfacing was not recorded. Hence, the encounter rates estimated are likely to be negatively biased.

Apart from the survey, while passing through the National Park East range (eastern part of STR) two groups of Irrawaddy Dolphin were sighted; one sighting of three animals in Chamta, and two in Baghmara. There was also a single sighting of the Indo-Pacific Hump-backed Dolphin (*Sousa chinensis* Osbeck, 1765) in the water channels of the National Park West range (Haldibari beat).

In the past few decades, the freshwater inflow in the western parts of Sundarbans has declined considerably due to the silting-up of the sources of all the rivers that flow into this region of the delta (Gopal and Chauhan 2006). The Farakka Barrage, built in 1974 on the River Ganga in India, has significantly contributed to this problem (Rahman 1986), and the increased salinity of the river waters in the Sundarbans has decreased the habitat for the Ganges River Dolphin (Reeves *et al.* 1993). A study conducted in the Bangladesh Sundarbans reported that Irrawaddy Dolphins occur in the western, high-salinity part of Bangladesh Sundarbans, while the Ganges River Dolphin occurs in the eastern low-salinity part, mostly in the upstream regions which received freshwater inflows (Smith *et al.* 2006). A study in STR (Mallick 2011) reported the occurrence of the Ganges River Dolphin in the upper reaches of the River Raimangal (eastern part of Indian Sundarbans) and that the animals descend to the lower portions of the river during the monsoon, as the salinity decreased. The presence of Irrawaddy Dolphin has been recorded in River Raimangal, Jhilla, and Amlamati, which comprise the north-eastern part of the Indian Sundarbans (Chakraborty and De 2007; Mallick 2011). Chakraborty and De (2007) reported the absence of Irrawaddy Dolphin from the northern part of the Indian Sundarbans in the monsoon season and attributed this to the decrease in salinity in the river waters. Over the past few decades, the changes in the salinity regimes of the Indian Sundarbans has most likely affected the distribution pattern of both Irrawaddy and Ganges River Dolphin. The data collected during this study suggests that the Irrawaddy Dolphin has a wide distribution in the waterways of the western portion of Sundarban Tiger Reserve, and that the presence of Ganges River Dolphin seems to be very low in this part of the Sundarban delta. It may also be pointed out that the single sighting of the Ganges River Dolphin was recorded in late May in this region, when the rains had started. It is possible that the distribution of Ganges River Dolphin in this part of Sundarbans is influenced by the rainy season since the salinity of the water channels is low during this season. But the data collected during this survey is not enough to draw a concrete conclusion about the status and distribution of these cetaceans. Hence, there is an urgent need to carry out an extensive status survey of these two cetaceans in the waters of the Indian Sundarbans.

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3. NESTING OF THE WHITE-RUMPED VULTURE *GYPS BENGALENSIS* IN ORCHHA WILDLIFE SANCTUARY, MADHYA PRADESH, INDIA

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Orchha Wildlife Sanctuary (46 sq. km; 25.35° N; 78.64° E) lies in Tikamgarh district of Madhya Pradesh, and is drained by the Betwa river. Orchha is a known nesting site for the Long-billed or Indian Vulture *Gyps indicus*. Unlike this species, there is lack of information on the breeding of the White-rumped or White-backed Vulture *Gyps bengalensis* in and around the Sanctuary in the past 10 years, according to the Forest Department and Dr. Munir Virani of the Peregrine Fund who has been monitoring the area for the last few years.

During a vulture census in Orchha Wildlife Sanctuary organised by the Forest Department from December 17–19, 2012, we sighted around 35 White-rumped Vultures and 15 active nests in trees on the banks of the River Betwa, which had a low density of trees, near the Orchha Wildlife Sanctuary, i.e., the Koti Gulena area. All the nests were on Arjuna *Terminalia arjuna* trees. The average height of the nests was 15.9 m (10–23 m range) and there were one to three nests per tree. All the eggs were in the incubation stage and there were two adults at each nest. With this observation, it is established that the White-rumped Vulture also breeds in Orchha Wildlife Sanctuary, and that the sanctuary is an important site for the breeding of two Critically Endangered vulture species.

We also recorded five other White-rumped Vultures, besides four Long-billed Vultures and two Indian Griffon *Gyps fulvus*, during the census.

ACKNOWLEDGEMENTS

We thank Mr. Vikas Yadav, Mr. Singhal (Conservator of Forests, Orchha), Dr. J. Rawat (Game Range Officer, Orchha), Dr. Amita Kanaujiya (Lucknow University), and Ms Sonika Kushwaha for inviting us for the workshop and census.

4. RECORD OF THE BRIDLED TERN *STERNA ANAETHETUS* IN AHMEDABAD, GUJARAT, INDIA

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On Friday, August 3, 2012, while returning from the airport, I saw a tern lying on the road near Nehru Bridge (72° 34' 70" N; 23° 37' 75" E). I picked up the bird and drove home. I was skeptical if it would survive, but offered live guppies and was surprised to see it eat three of them on its own. However, it died the next day.

Referring to field guides of Indian birds, I checked images of terns which had black wings, a white belly, and forked tail. I first felt that it was a Sooty Tern *Sterna fuscata*, but it lacked the long white supercilium. However, on checking Grimmett *et al.* (1999), I saw that the tern resembled the Bridled Tern *S. anaethetus*. The Bridled Tern is generally seen on sea coasts. This is probably the first record of the species inland, i.e., Ahmedabad, Gujarat. The bird could probably have come here by following the River Sabarmati from the Gulf of Khambat (as suggested by Ketan Tatu of Geer Foundation, Gandhinagar), or it got caught in strong winds and was blown inland.

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5. RECORD OF SOOTY TERN *STERNA FUSCATA* IN PUNE, MAHARASHTRA, INDIA

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On August 1, 2012, at around 16:00 hrs, I received a call from my neighbour that a few crows were trying to attack a bird near our housing society in Kothrud, Pune. I asked him to protect the bird, and on rushing to the spot, saw that it was not a bird seen in Pune area. I took some pictures of the bird and mailed them to friends; the bird was identified as a juvenile Sooty Tern *Sterna fuscata* by experts Kishor Gumaste, Asad R. Rahmani, and Rahul Rao.

The Sooty Tern is a pelagic species that is known to breed in Lakshadweep, Vengurla Rocks (southern Maharashtra), and probably Maldives, Andamans, and west and south Sri Lanka (Manakadan *et al.* 2011). It has been reported to stray inland to Tamil Nadu, Bihar, and Assam (Manakadan *et al.* 2011), but this is probably the first record of the species from Pune, which is about 200 km off the Maharashtra coast. I took the bird to the Katraj Animal Orphanage in Pune, but it died next morning. The specimen was handed over to the Zoological Survey of India, Pune.

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6. FIRST RECORD OF THE BLUE-AND-WHITE FLYCATCHER *CYANOPTILA CYANOMELANA* IN INDIA

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On the morning of March 10, 2012, while birding on the western slopes of the Siddheshwar Hill, about six kilometres north-west of Alibag, Raigad district, Maharashtra, I saw a bird sitting on the branch of a *Bombax ceiba* tree. The bird was bright blue with white underparts, resembling some of the blue flycatchers (*Cyornis* spp.) found in Maharashtra. As I was not able to identify it, I took some photographs, and posted them on the internet. The bird was sighted at a location 18° 39' 37.13" N and 72° 56' 09.25" E, and the elevation was about 118.8 m above msl. I got many replies, including those of well-known ornithologists Krys Kazmierczak, Craig Robson, and Pamela Rasmussen, who identified it as the Blue-and-White Flycatcher *Cyanoptila cyanomelana*. This is the first record of the species in India (ed.: photographic evidence provided), as it has not been previously reported from the Indian subcontinent (see Ali and Ripley 1983; Grimmett *et al.* 2011; Rasmussen and Anderton 2012).

The Blue-and-White Flycatcher breeds in Japan, Korea, parts of China and Russia, and winters in Southeast Asia (Vietnam, Cambodia, Thailand, Sumatra, and Borneo). It inhabits wooded areas in lowlands and submontane forests, wooded slopes, and gullies up to 1,200 m. It can also be found in scrub, bushes, and plantations. During migration or in wintering areas, it can be found in coastal woodlands, parks, and gardens. It may winter at high altitudes in Borneo, up to 2,000 m.

The adult male Blue-and-White Flycatcher has most of its upperparts cobalt blue, including upper wing-coverts, flight feather edges, and tail. The head, crown, and nape are shiny cobalt blue. The lower part of the forehead and face are black. The primaries are black. Secondary feathers show black inner webs. The outer tail feathers are white at the base, only visible in flight. The chin, throat, breast, and flanks are black, whereas the belly and vent are white. Eyes dark brown; bill black, and legs and feet are dusky.

ACKNOWLEDGEMENTS

I thank Dr. Vaibhav Deshmukh from Alibag who accompanied me. Sincere thanks to Mr. Krys Kazmierczak, Craig Robson, and Dr. Pamela Rasmussen for help in identification of the species, besides other birdwatchers who indicated that the species was different from the other blue flycatchers. Thanks to Dr. Asad R. Rahmani, Director, BNHS, and Dr. Raju Kasambe for encouraging me to write a scientific note on this finding in *JBNHS*.

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7. SIGHTING OF JERDON'S BUSHCHAT *SAXICOLA JERDONI* IN PILIBHIT, UTTAR PRADESH, INDIA

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Jerdon's Bushchat *Saxicola jerdoni* is an uncommon resident bird of tall grasslands of the sub-Himalayan plains from east Bihar and west Bengal to north-east India in the Brahmaputra watershed, lower parts of south Assam hills and north-east Bangladesh (Rasmussen and Anderton 2005). Although it has been reported as far west as the Uttar Pradesh and western Nepal border, there have been no recent records from the Terai of Uttar Pradesh. Javed and Rahmani (1998) during their study of birds in Dudhwa National Park from 1991 to 1994 did not record the species.

On the morning of April 28, 2013, while surveying and photographing the birds of Haripur Forest Range, 60 km from Pilibhit, Uttar Pradesh, I sighted two adult Jerdon's Bushchat in tall open dry grassland in a forest clearing. They were calling loudly, which drew my attention. They had white underparts and were completely black above. I managed to take a few photographs before they flew away. The birds were seen with Blue-tailed Bee-eater *Merops philippinus*, Black Drongo *Dicrurus macrocercus*, and Grey Bushchat *Saxicola ferreus*, another uncommon bird.

ACKNOWLEDGEMENT

I am grateful to Dr. Asad R. Rahmani, Director, for confirming the identity and also for comments on the original manuscript.

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8. SECOND RECORD OF THE TRICOLORED MUNIA *LONCHURA MALACCA* FROM SOUTHERN RAJASTHAN, INDIA

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The Chestnut Munia *Lonchura malacca* consists of two subspecies, namely *malacca* which has a white belly, and *atricapilla* which has a chestnut belly. The white-bellied race is now largely considered as a separate species, i.e., Tricolored Munia *Lonchura malacca* (see Rasmussen and Anderton 2012). The Tricolored Munia is endemic to the Indian subcontinent, and is distributed in the Peninsula roughly south of Gujarat and southern Orissa, and in Sri Lanka (Ali and Ripley 1987; Grimmett *et al*. 1999; Manakadan *et al*. 2011; Rasmussen and Anderton 2012).

On August 30, 2012, while birding in the morning at Menar pond, Udaipur (24° 35' 16" N; 74° 06' 43" E; 1,563 m above sea level), we noticed a bird in the thicket of *Prosopis juliflora* near an agricultural field, and photographed it. It had a black head, throat, and nape, while the rest of the upperparts were rufous-chestnut. The ventral surface was white. The bird was identified as the Tricolored Munia with the help of field guides. The area of sighting of the bird was characterised by agricultural fields surrounded by the local vegetation, the common species being *Acacia senegal*, *Grewia tenax*, *Grewia flavescens*, *Cassia auriculata*, *Prosopis juliflora*, *Diospyros montana*, *Heteropogon contortus*, *Sehima nervosum*, *Lannia grandis*, and *Euphorbia caducifolia*.

August is the monsoon season in southern Rajasthan, and the heavy rainfall creates a lush green environment. According to Ali and Ripley (1987), May to November is the breeding season of this species.

Studies on the avifauna in Rajasthan (Abudulali and Panday 1978; Shahabuddin *et al.* 2006), including southern region (Chhangani 2002; Koli *et al.* 2011; Sangha and Devarshi 2006; Saxena 2003; Sharma 1998; Sharma and Tehsin 1994), did not report the presence of this species in southern Rajasthan. The only other report of the species in Rajasthan was by Sharma (1999), who had seen a flock of seven birds in November 1998 in the same district as our sighting. Our observation was in August 2012 at the peak of the monsoon, but Sharma (1999) recorded it towards the end of the monsoon season. The rainy season generally starts in July and ends in October; the peak is from July to September. Other munias like Scaly-breasted Munia *Lonchura punctulata* and Red Avadvat *Amandava amandava* are also seen from July to October.

The Tricolored Munia has been reported from Jasdan, Gujarat (Ali and Ripley 1987), which is about 450 km from the site recorded in Udaipur. It appears that the recent occurrence of the Tricolored Munia in southern Rajasthan is not a result of escapees, but a case of range extension (from Gujarat). Munias are neither sold nor kept as cage birds in southern Rajasthan and adjoining areas of Banaskantha and Sabarkantha districts of northern Gujarat. Additionally, southern Rajasthan has suitable habitat for munia species as it has a variety of grasslands and now sugarcane is also grown, especially in the Jhadol, Kotra, Gogunda, Sayra, and Kumbhalgarh areas. Additionally, paddy is cultivated in the low-lying areas during the rainy season, which also attracts munias. These changes must have attracted munia species, including the Tricolored Munia, to inhabit the area.

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9. CATALOGUE OF SALAMANDER AND NEWT (AMPHIBIA: URODELA/CAUDATA) SPECIMENS IN THE COLLECTION OF THE ZOOLOGICAL SURVEY OF INDIA

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Salamanders and newts, belonging to the amphibian Order Urodela/Caudata, are characterised by the presence of a tail in the adult stage. Most salamanders have four equal sized limbs, and those with aquatic swimming larvae have external gills and limbs from an early stage. However, in some, metamorphosis is delayed and the larvae become sexually mature (neotenous and paedomorphic) (Duellman and Trueb 1986). There are 619 species in nine recognised families worldwide, most living in North America, Europe, and northern Asia (Frost 2011). Only one species – *Tylototriton verrucosus* – is known from India (Deuti and Hegde 2007).

Over the years, a substantial collection of Urodelan specimens from all over the world have accumulated in the Zoological Survey of India (ZSI), which were either handed over from the old British era collections of the Asiatic Society of Bengal to the Indian Museum, and subsequently to the ZSI when it was established in 1916, or by exchange with other museums. The Indian species was obtained during collection surveys by ZSI and from donations received from two individuals from Manipur and Nepal.

The collections of 206 Urodelan specimens belonging to 23 species, 18 genera, and 7 families existing in the Zoological Survey of India Collection as on March 31, 2012, are catalogued in Table 1.

Table 1: Catalogue of 206 Urodelan specimens belonging to 23 species, 18 genera, and 7 families, in the collection of Zoological Survey of India as on March 31, 2012

Labelled name	Current Nomenclature	Registration Number	Locality	Collector and Date of Collection	Remarks
Family: Ambystomatidae					
Ambystoma jeffersonianum (Green, 1827)	*Ambystoma jeffersonianum* (Green, 1827)	12305 12306 12307 12308	Huron Lake, USA and Canada	J.H. Garnier	4 specimens

Table 1: Catalogue of 206 Urodelan specimens belonging to 23 species, 18 genera, and 7 families, in the collection of Zoological Survey of India as on March 31, 2012 (*contd.*)

Labelled name	Current Nomenclature	Registration Number	Locality	Collector and Date of Collection	Remarks
Ambystoma mavortium Baird, 1850	*Ambystoma mavortium* Baird, 1850	12195	Kansas, USA	1850	1 specimen
Axolotl larvae	*Ambystoma mexicanum* (Shaw and Nodder, 1798)	A 11366	Not mentioned	Maria Jordan, Polish Academy, Poland	3 specimens by exchange
Ambystoma punctatum Hay, 1892	*Ambystoma maculatum* (Shaw, 1802)	12309	Lake Erie, USA	J.H. Garnier	1 specimen
Family: Cryptobranchidae					
Megalobatrachus maximus Boulenger, 1882	*Andrias japonicus* (Temminck, 1836)	20484	Japan	W. Reetledge	1 specimen
Cryptobranchus alleghaniensis (Daudin, 1803)	*Cryptobranchus alleghaniensis* (Daudin, 1803)	11377 11378 11472	Pennsylavania, USA	Schneider	3 specimens were presented
Family: Sirenidae					
Siren lacertina Linnaeus, 1766	*Siren lacertina* Linnaeus,1766	11474	South Carolina, USA	Schneider,	1 specimen were presented
		12765	Lousiana, USA	J.H. Garnier	1 specimen by exchange
Family: Hynobiidae					
Hynobius nebulosus (Temminck & Schlegel, 1838)	*Hynobius nebulosus* (Temminck & Schlegel, 1838)	12295 12296	Yezo, Japan	John Anderson	2 specimens
Onychodactylus japonicus (Houttuyn, 1782)	*Onychodactylus japonicus* (Houttuyn, 1782)	12984 12985 12986 12987 12988 12989 12991 12992	Hukona, Japan	John Anderson	8 specimens
Family: Plethodontidae					
Batrachoseps attenuatus (Eschscholtz, 1833)	*Batrachoseps attenuatus* (Eschscholtz, 1833)	A 4055	Pasadena County, California, USA	S.B. Emerson, November 1970	3 specimens
Batrachoseps major Camp, 1915	*Batrachoseps major* Camp, 1915	A 4056	Pasadena County, California, USA	S.B. Emerson, November 1970	2 specimens
Desmognathus niger Baird, 1850	*Desmognathus quadramaculatus* (Holbrook, 1840)	10400	North Carolina, USA	F. Fitzgerald	1 specimen
Plethodon cinereus (Green, 1818)	*Plethodon cinereus* (Green, 1818)	12298 12299 12300 12301 12302 12303	Ontario, Canada	J.H. Garnier	6 specimens
Family: Proteidae					
Proteus anguinus Laurenti, 1768	*Proteus anguinus* Laurenti, 1768	10423	Not mentioned	Not mentioned	1 specimen

Table 1: Catalogue of 206 Urodelan specimens belonging to 23 species, 18 genera, and 7 families, in the collection of Zoological Survey of India as on March 31, 2012 (*contd.*)

Labelled name	Current Nomenclature	Registration Number	Locality	Collector and Date of Collection	Remarks
Family: Salamandridae					
Diemictylus pyrrhogaster Stejneger, 1907	*Cynops pyrrhogaster* (Boie, 1826)	12969	Lake Biwa, Japan	John Anderson	14 specimens
		12970			
		12973			
		12974			
		12975			
		12976			
		12977			
		12978			
		12979			
		12980			
		12981			
		12982	Hanchow, China	Shanghai Museum	
		18059	Kyoto, Japan		
		18215		Nelson Annandale	
Molge rusconii Boulenger, 1882	*Euproctus platycephalus* (Gravenhorst, 1829)	13378	Sardinia, Italy	Prof. Giglioli (Florence Museum)	2 specimens by exchange
		13379			
Molge wolterstorffi Boulenger, 1905	*Hypselotriton wolterstorffi* (Boulenger, 1905)	15752	Yunnan fu, China	G.A. Boulenger	1 specimen by exchange
Molge palmata Merrem, 1820	*Lissotriton helveticus* (Razoumovsky, 1789)	10418	Brussels, Belgium	G.A. Boulenger	13 specimens
		10419			
		10420			
		10421			
		13046			
		13047			
		13048			
		13049			
		13373	Corsica, France	Prof. Giglioli (Florence Museum)	
		13374			
		13375			
		13376			
		13377			
Diemictylus viridescens Gill, 1907	*Notopthalmus viridescens* (Rafinesque, 1820)	12289	Ontario, Canada	J.H. Garnier	4 specimens
		12290			
		12291			
		12292			
Salamandra maculosa Laurenti, 1768	*Salamandra salamandra* (Linnaeus, 1758)	10391	France	Malherbe,	3 specimens
		10407	Lake Como, Italy	Prof. Cornalia	
		10408			
Molge cristata Boulenger, 1882	*Triturus cristatus* (Laurenti, 1768	10403	Lombardy, France	Prof. Cornalia	2 specimens
		10405			
Molge marmorata Boulenger, 1882	*Triturus marmoratus* (Latreille, 1800)	13038	Bordeaux, France	G.A. Boulenger	3 specimens by exchange
		13039			
		13040			

Table 1: Catalogue of 206 Urodelan specimens belonging to 23 species, 18 genera, and 7 families, in the collection of Zoological Survey of India as on March 31, 2012 (*contd.*)

Labelled name	Current Nomenclature	Registration Number	Locality	Collector and Date of Collection	Remarks
Tylototriton verrucosus Anderson, 1871	*Tylototriton verrucosus* Anderson, 1871	10366 10368 10374 10375 10377 10378 10970	Momein, Yunnan (China)	John Anderson	11 syntypes of the species
		10971 10972 10380 10381	Ponsee, Kakhyen hills, Myanmar		
Tylototriton verrucosus Anderson, 1871	*Tylototriton verrucosus* Anderson, 1871	A 1883 A 1884 A 1885	Dingla Pokhari, Bhojpur district, Nepal	Dambar Bahadur Pradhan 21.v.1965	3 specimens donated
Tylototriton verrucosus Anderson, 1871	*Tylototriton verrucosus* Anderson, 1871	A 4269	Tihun, Lohit district, Arunachal Pradesh	J.M. Julka 14.xii.1969	1 specimen
Tylototriton verrucosus Anderson, 1871	*Tylototriton verrucosus* Anderson, 1871	A 11367	Manipur, India	Ekendra Singh, November 1976	4 specimens donated
Tylototriton verrucosus Anderson, 1871	*Tylototriton verrucosus* Anderson, 1871	A 11368	Tibetan Nayabasti, Sonada (alt. 1,965 m), Darjeeling district, West Bengal	A.R. Bhaumik 7.v.1971	17 specimens
Tylototriton verrucosus Anderson, 1871	*Tylototriton verrucosus* Anderson, 1871	A 11369	Pacheng, Sonada (alt. 1,815 m), Darjeeling district, West Bengal	A.R. Bhaumik 9.v.1971	81 specimens
Tylototriton verrucosus Anderson, 1871	*Tylototriton verrucosus* Anderson, 1871	A 11370	Mirik, Darjeeling district, West Bengal	M.R. Mansukhani 24.v.1972	4 specimens
Tylototriton verrucosus Anderson, 1871	*Tylototriton verrucosus* Anderson, 1871	A 11371	Hima falls, 2 km north of Ghum Bhanjan, Darjeeling district, West Bengal	M.R. Mansukhani 26.v.1972	1 specimen
Tylototriton verrucosus Anderson, 1871	*Tylototriton verrucosus* Anderson, 1871	A 11372	Sonada (alt. 1,815 m), Darjeeling district, West Bengal	A.K. Sarkar	1 specimen
Tylototriton verrucosus Anderson, 1871	*Tylototriton verrucosus* Anderson, 1871	A 11459 A 11460 A 11461 A 11462	Lake inside Margaret Hope Tea Estate (alt. 1,610 m), Darjeeling district, West Bengal	K. Deuti & V.D. Hegde 18.vii.2006	4 specimens

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10. SEXUAL DIMORPHISM IN *HYPSELOBARBUS KURALI* (PISCES: CYPRINIDAE)

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Hypselobarbus kurali is distributed in the south-western rivers of peninsular India, and the species is protected in the Kulathupuzha Temple Sanctuary, Kollam, Kerala. *Hypselobarbus kurali* was described by Menon and Rema Devi (1995) on the basis of the following characteristics: four barbels, a weak articulated last undivided ray with nine branched rays in the dorsal fin, 41–43 scales along the lateral line, 3½ to 4½ rows of scales between the lateral line and pelvic origin; silvery with somewhat greyish black body, a deep black bar behind the gill opening, and caudal tipped black.

While examining the monthly fish collections during 2012 (January to December) from Kulathupuzha hill streams, an obvious sexual dimorphism in the length of the anal fin in specimens of *H. kurali* was observed throughout the year, besides the nuptial tubercles noted in males during the post-monsoon season extending from October to December. The females have greater anal fin length (ranging from 23.40–28.00%) than males (14.04–16.80%), calculated as a percentage of the standard length of fish from the detailed examinations and dissections carried out on 200 specimens consisting of 113 females and 87 males. In females, the anal fin extends the whole length of the caudal peduncle and ends subsequent to the caudal fin base. However, in males it extends almost to the middle of the caudal peduncle (Fig. 1).

Morphological differences in fish families reporting sexual dimorphism are with regard to body size, coloration, fin length, nuptial tubercles, and intromittent organs (Scott and Crossman 1973), and according to them, the most common sexual dimorphic characters for Cyprinids are the coloration and presence of nuptial tubercles. Various studies have been carried out on sexual dimorphism in fish giving importance to fin length such as in *Rhinichthys osculus*, *Gilia bicolor*, *Relictus*

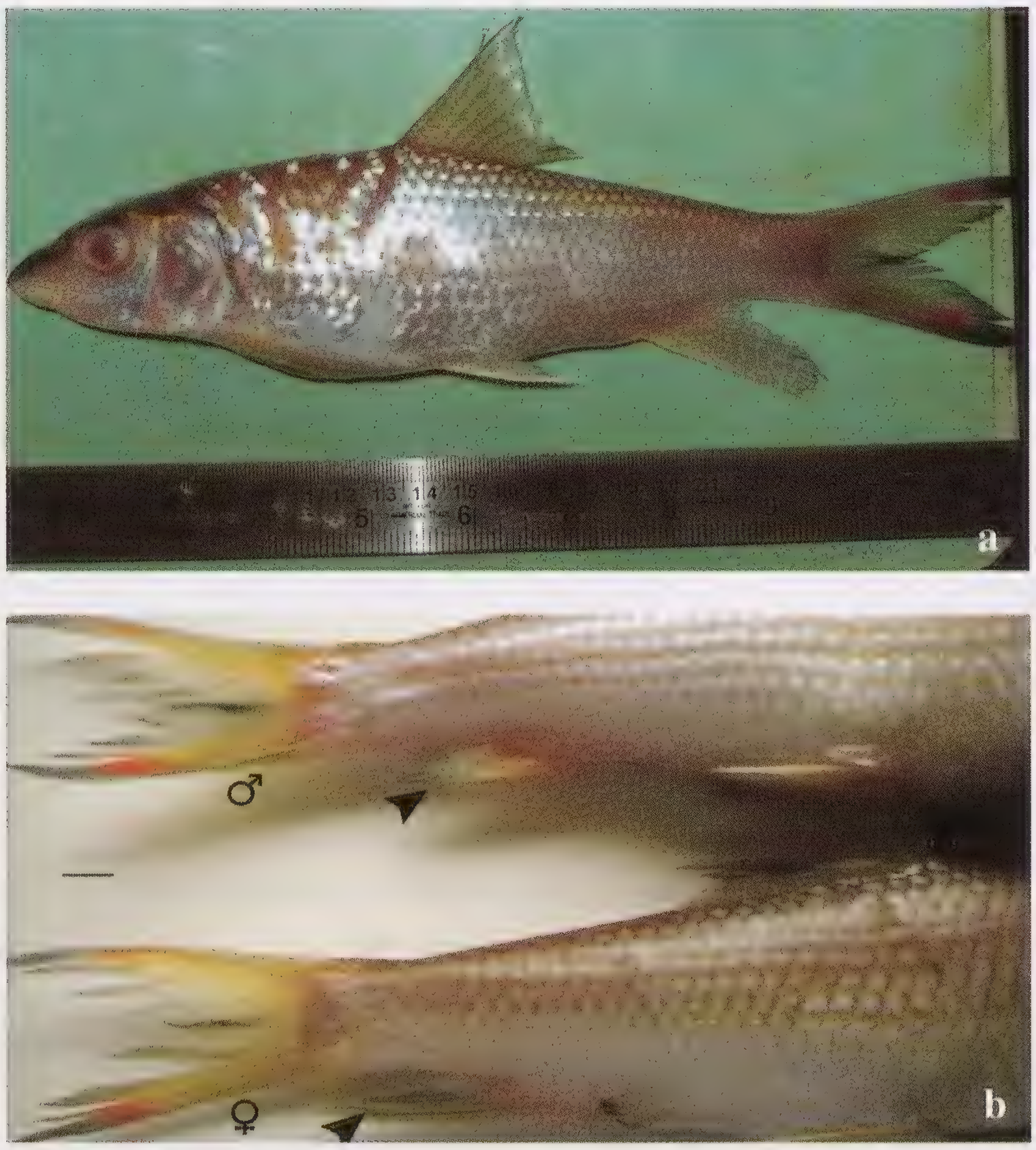

Fig. 1: a. *Hypselobarbus kurali*, b. Sexual dimorphism in *H. kurali* (Scale bar = 1.5 cm)

solitarius (Hubbs *et al.* 1974; Sigler and Sigler 1987), *Notropis hubbsi* (Bailey and Robinson 1978), and *Hybognathus placitus* (Kenneth *et al.* 2001). In *H. kurali*, we found that those with longer anal fin were females in the case of specimens ranging from 15–26 cm. The collections mainly depend on the mesh size of the fishing gear. The one used by us was the Sardine Gill Net (mesh size 3.5 cm), which is commonly used in the midstreams of the Kulathupuzha region. On the basis of these collections, it was concluded that sexual dimorphism is present in *H. kurali* having a size >15 cm (and up to 26 cm) – the species grows up to a length of 31 cm (which was the maximum length caught till date in the present study). This is the first information on fin length related sexual dimorphism in a *Hypselobarbus* species which is distributed along the Western Ghats region of India. The voucher specimens of *H. kurali* were deposited in the Bombay Natural History Society's Collections and the details are as follows:

Hypselobarbus kurali: 3.i.2013, 1 ex. Female, 224 mm SL, Kulathupuzha, BNHS FWF 11

Hypselobarbus kurali: 3.i.2013, 1 ex. Female, 198 mm SL, Kulathupuzha, BNHS FWF 12

Hypselobarbus kurali: 3.i.2013, 1 ex. Male, 177 mm SL, Kulathupuzha, BNHS FWF 13

Hypselobarbus kurali: 3.i.2013, 1 ex. Male, 186 mm SL, Kulathupuzha, BNHS FWF 14

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11. OBSERVATION ON A COLLECTION OF TAWNY COSTER *ACRAEA TERPSICORE* (PIERIDAE: LEPIDOPTERA) IN THE WEB OF THE SOCIAL SPIDER *STEGODYPHUS SARASINORUM* (ERESIDAE: ARANEAE)

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Social spiders live in communal webs where there are no individually defended territories (D'Andrea 1987). They cooperate in capturing prey which is then shared by individuals of the group, even by those that did not participate in the actual prey capture (Bradoo 1980). This way they can handle larger prey than most similar sized solitary spiders. Most social spiders feed on whatever is captured in their webs, especially insects such as grasshoppers, butterflies, wasps, moths, flies, and beetles (Sebastian and Peter 2009).

During a morning birding visit, on January 29, 2011, to a lake at Gavier village (21° 07' 36.45" N; 72° 44' 10.53" E), near Surat, Gujarat, I had an unusual sighting of a large number of butterflies in a spider web. The web was an irregular ball, situated at the tip of a *Ziziphus jujuba* tree about 6–8 feet (above the ground). On close inspection, I found that there were around 20–25 butterflies (ed.: photographic evidence provided), and interestingly, all of them were Tawny Coster (*Acraea terpsicore*, Pieridae: Lepidoptera). Along with them were some beetles and dragonflies and three or four dead individuals of *Stegodyphus* sp. spiders. I was able to photograph the two species of spiders seen on the web, which were later identified as *Stegodyphus sarasinorum* (Family Eresidae) and *Drassodes* sp. (Family Gnaphosidae). I also found three Tawny Coster butterflies in a similar smaller web on a branch adjacent to the first.

The web structure and presence of the species confirmed that both the webs belonged to *S. sarasinorum* (Sebastian and Peter 2009). *S. sarasinorum* is one of three permanently cooperative species of the genus *Stegodyphus*, and is distributed in India, Sri Lanka, Nepal, and Myanmar (Platnick 2013). It is frequently accompanied by spiders belonging to Salticidae, Arenidae, and Gnaphosidae families (G. Vankhede pers. comm.). The Tawny Costers were probably present in large numbers at the site due to the abundance of flowers of *Passiflora foetida*, one of their favoured host plants. Other than the Tawny Coster, Small Salmon Arab *Colotis amata*, Common Grass Yellow *Eurema hecabe*, Plain Tiger *Danaus chrysippus*, Striped Tiger *Danaus genutia*, and Common Gull *Cepora nerissa* were also found in abundance at the site.

Although butterflies form a considerable part of the diet of genus *Stegodyphus* (Bradoo 1980; Willey and Jackson 1993), such unusual incidents of capture and collection of individuals belonging to a single species is rare, and thus is worth recording. The possible reason why only this species of butterfly, among the others seen in the area, was caught in the web is interesting and also puzzling.

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12. *HETEROPODA FISCHERI* JÄGER, 2005: A HUNTSMAN SPIDER HUNTING ON FELLOW CAVERNICOLES IN THE CAVES OF MEGHALAYA, INDIA

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Huntsman spiders, members of the family Sparassidae, are carnivorous, feeding mostly on insects and other invertebrates (Harries *et al.* 2008; Nyffeler and Symondson 2001; Wise 1993); they hunt by pouncing on the prey and killing it with the venom injected. It seems a natural transition for such a group of small predators to gravitate toward subterranean habitats where they have access to easily available prey (Biswas 2010).

Heteropoda fischeri, a species of huntsman spider, was first identified from the caves of Jaintia Hills, Meghalaya (Jäger 2005), and later from other caves of the region (Biswas and Harries 2011; Harries *et al.* 2008). Early reports document *H. fischeri* preying upon brown Rhaphidophorid cave crickets in the Jaintia Hills (Harries *et al.* 2008) and other caves in Meghalaya. Predator-prey relationships between Rhaphidophorid crickets and huntsman spiders were later also reported from other areas (Biswas and Shrotriya 2011; Culver and White 2005; Gunn 2004).

Meghalaya has vast tracts of limestone deposits up to a depth of 500 m. The combination of significant limestone deposits and high rainfall have produced several water carved subterranean caves of notable length and depth here, though only a fraction of these have been explored and mapped. Even among the caves explored, biospeleological surveys have been limited (Biswas 2009; Biswas and Harries 2011; Disney 2009; Harries *et al.* 2008; Kottelat *et al.* 2007). As part of International Cave Expedition – 2011, organised by Meghalaya Adventurers' Association, India, we explored a few caves in the Pala range of Jaintia Hills district, Meghalaya. Most of these caves were river caves and reflect the same biotic components which have been previously reported by Harries *et al.* (2008). We found the initial shallow corridors of almost all the caves to be occupied by some species of Pulmonata (snails and slugs), besides other cavernicolous organisms such as crickets, spiders, and harvestmen. During the trip to the Hostage Cave, we witnessed an interesting predator-prey relationship involving a huntsman spider and slug, which is discussed in this note.

Hostage Cave (25° 25' 22.6" N; 92° 35' 05.7" E), is a small subterranean cave that opens through a narrow and twisted opening. The twilight and transitional zones of this cave are quite shallow in nature, whereas the inner passageway is more of a substantial river conduit. The water-swept side-walls of the cave suggest that most parts of the cave associated with the river remain submerged during the rains. During one of our visits to the cave, we saw an unidentified pulmonate slug moving on the wall of the cave that was being targeted by the huntsman spider *Heteropoda fischeri.* The spider grabbed the slug, and on this, the slug tried to escape by expanding and contracting its body, but it was apparent that the spider's venom was paralyzing the slug. Finally the prey was rendered paralyzed, and the spider started masticating at a slime-free part of its body.

Slugs have been reported as prey of several invertebrate species, including beetles, centipedes and harvestmen (Breure 2011; Symondson 2004). A recent review by Nyffeler and Symondson (2001) reported 12 Araneae families to be among the 53 reported predators of snails and slugs. However, ours is the first report of predation by a spider on a pulmonate slug in a hypogean ecosystem.

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13. A STEP FURTHER TO THE CORRECT IDENTIFICATION OF *CEROPEGIA BULBOSA* ROXB. IN KACHCHH, GUJARAT, INDIA

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Introduction

Ceropegia Linn. is one of the most fascinating genera in the milkweed family (Asclepiadaceae) and has variable and highly unusual flowers. *Ceropegia* is derived from 'keros' meaning wax, and 'pege' meaning fountain, as the flowers are said to look like a fountain of wax. They are twining, rarely erect herbs, glabrous, rarely pubescent, with tubers. Leaves membranous or fleshy, at times reduced. Flowers sessile or pedunculate, solitary to many-flowered in sub-umbellate cyme, and seeds comose (Jagtap and Singh 1999). Asclepiadaceae is characterised by bicarpellary, syncarpous, superior ovary (Santapau and Irani 1960) and its specialised corolla (Jagtap *et al.* 2004). The family is well-known for endemism – the most elaborate and complicated flower among all dicots – and for contrivances for pollination (Kamble and Yadav 2004).

Intensive survey of *Ceropegia* spp. was done for three years in Kachchh – the northernmost district of Gujarat. In past studies from Gujarat, *Ceropegia bulbosa* Roxb. was classified up to species level. The present manuscript deals

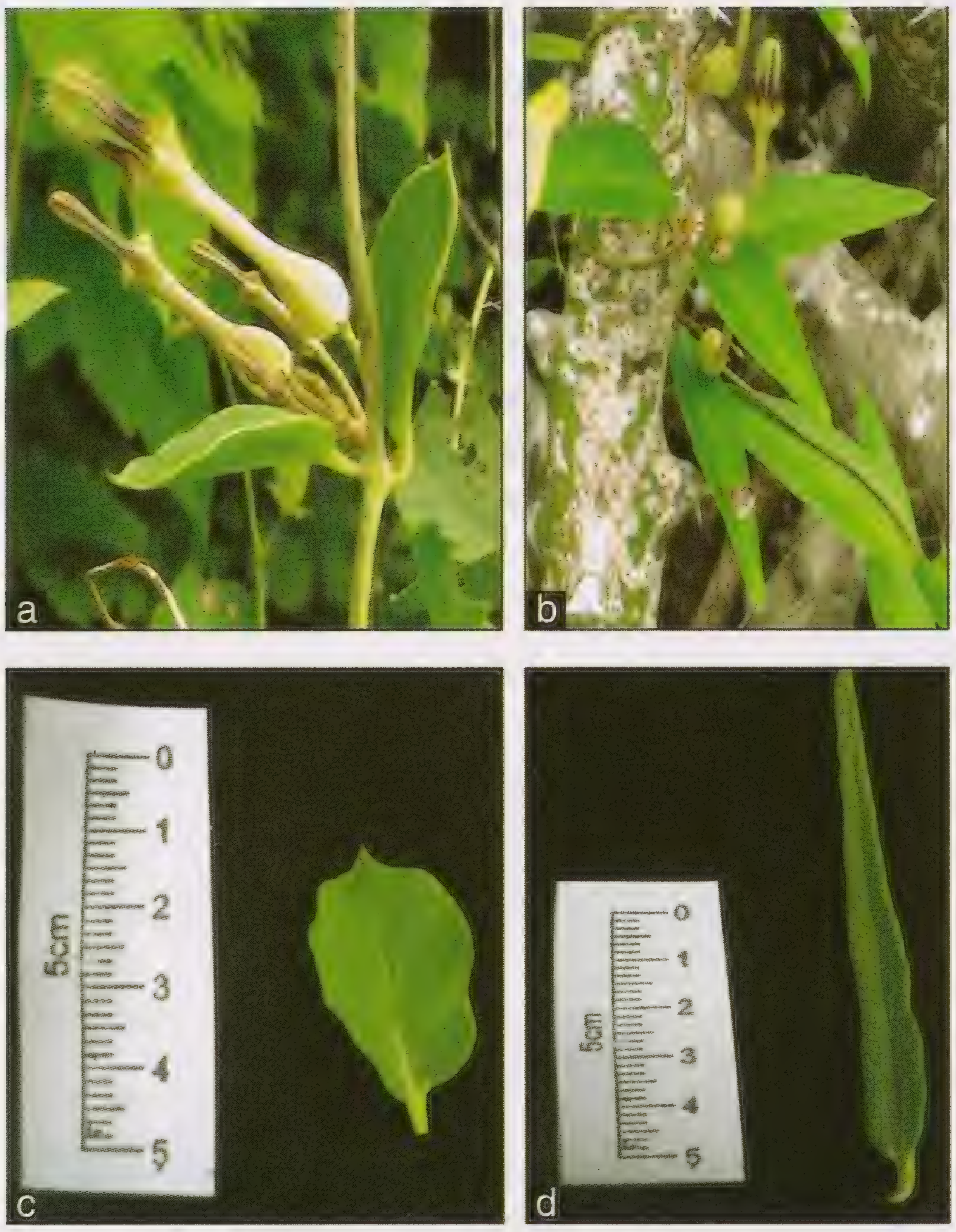

Fig. 1: a. *Ceropegia bulbosa* Roxb. var. *bulbosa* Hook f.;
b. *Ceropegia bulbosa* Roxb. var. *lushii* (Grah) Hook f.;
c. Leaf of *Ceropegia bulbosa* Roxb. var. *bulbosa* Hook f.;
d. Leaf of *Ceropegia bulbosa* Roxb. var. *lushii* (Grah) Hook f.

with its detailed key characters for further identification, and gives an account of two different varieties in the State.

Observations

On the basis of floral characters, the collected plants were identified as *Ceropegia bulbosa* Roxb. in the field survey. It was noticed that the leaf characters of two plants among the specimens collected were different from each other, though their flowers were the same. Both plants (Figs 1a, b) were found growing together in natural conditions in association with *Euphorbia neriifolia* L. and/or *Salvadora oleoides* Decne. Leaves of one of the specimens are orbicular and elliptic-oblong (Fig. 1c), while those of the other (Fig. 1d) are narrowly linear (Table 1). According to the FLORA OF GUJARAT STATE (Shah 1978), three species of genus *Ceropegia* are found in Gujarat: *C. bulbosa* Roxb., *C. candelabrum* L., and *C. odorata* Hook f. The floral characters of the collected specimen match the species *Ceropegia bulbosa* Roxb., except leaf characters.

Table 1: Length and width of *Ceropegia* leaves and petiole in the field (average of at least 100 specimens)

Plant	Leaves (cm) (Mean ± S.E.)		(Petiole cm) (Mean ± S.E.)
	Length	Width	
Ceropegia bulbosa Roxb. var. *bulbosa*	4.05 ± 0.16	1.92 ± 0.07	1.06 ± 0.05
Ceropegia bulbosa Roxb. var. *lushii*	10.09 ± 0.04	0.64 ± 0.05	0.45 ± 0.03

The specimens were sent for further opinion to Professor S.R. Yadav (Shivaji University, Kolhapur). Based on the characteristics and his expert opinion, the specimens were assigned to the same genus and species *Ceropegia bulbosa* Roxb., but two different varieties. Therefore, the correct identification of these two specimens is *Ceropegia bulbosa* Roxb. var. *bulbosa* Hook f. (Fig. 1a) and *Ceropegia bulbosa* Roxb. var. *lushii* (Grah) Hook f. (Fig. 1b). The key to the two varieties is given (Yadav and Sardesai 2002):

1. Climbing herbs, Stem twining. Leaves fleshy .... *C. bulbosa*
– Leaves exceeding one inch long, never wanting . 2, 3
2. Leaves subsessile to petiolate, the lowest almost orbicular, upper ones elliptic oblong or obovate, usually apiculate .... *C. bulbosa* var *bulbosa*
3. Leaves petiolate, narrowly linear-lanceolate .... *C. bulbosa* var *lushii*

Ceropegia bulbosa Roxb Pl. Corom. 1; 11.t.7.1795 **var.** ***bulbosa*** Hook f. Fl. Brit. India 4:67.1883; Cooke, Fl. Pres. Bombay 2: 240. 1958 (Repr.); Jagtap & Das Das in Singh *et al.*, Fl. Maharashtra St. Dicot. 2: 349. 2001.

Tuberous twining herbs. Leaves subsessile to petiolate, glabrous, the lowest almost orbicular, the upper ones elliptic-oblong or obovate, rarely elliptic-lanceolate, usually apiculate, base rounded, truncate, subcordate or acute. Cymes shortly pedunculate. Corolla greyish purple; inflated at the base, narrowed in the middle, funnel-shaped above, glabrous within; lobes hairy inside and on margins. Outer corona

Table 2: Occurrence of *Ceropegia* in Lakhpat district, Kachchh

Variety	Place	Longitude	Latitude
Ceropegia bulbosa Roxb. var. *bulbosa*	Dayapar	23° 37' 04.3" N	68° 53' 22.5" E
	Dayapar	23° 37' 06.0" N	68° 53' 19.5" E
	Virani	23° 39' 06.0" N	68° 50' 56.3" E
	Virani	23° 39' 04.8" N	68° 50' 58.1" E
Ceropegia bulbosa Roxb. var. *lushii*	Dayapar	23° 37' 05.8" N	68° 53' 19.4" E
	Virani	23° 39' 06.0" N	68° 50' 56.3" E

saucer-shaped, entire or broadly shallow; inner sickle-shaped.

Fl. & Fr.: August–November.

Frequent amidst bushes in grasslands.

Ceropegia bulbosa Roxb. **var. *lushii*** (Grah) Hook f. Fl. Brit. India 4: 68. 1883; Cooke, Fl. Pres. Bombay 2: 241. 1958 (Repr); Jagtap & Das Das in Singh *et al.,* Fl. Maharashtra St. Dicot. 2: 249. 2001.

Tuberous twining herbs. Leaves petiolate, fleshy, narrowly linear-lanceolate, glabrous, acuminate. Corolla greyish purple, inflated at the base, narrowed in the middle, funnel-shaped above, glabrous within; lobes hairy inside and on the margins. Outer corona saucer-shaped, entire or broadly shallow; inner sickle-shaped.

Fl. & Fr.: August–November.

Rare, along with *C. bulbosa* var. *bulbosa* Hook f., amidst bushes in grasslands.

Discussion

The FLORA OF GUJARAT STATE (Shah 1978) is a broadly accepted source describing the plant diversity of Gujarat State. This FLORA reported the occurrence of three species of *Ceropegia*, namely *C. bulbosa* from Kachchh (Table 2), Saurashtra, and throughout in plains; *C. candelabrum* from Pavagadh hill; and *C. odorata* from Pavagadh. Moreover, in the FLORA OF THE PRESIDENCY OF BOMBAY (Cooke 1958), *C. bulbosa* var. *bulbosa* Hook f. was reported from Konkan: Malabar Hill and *C. bulbosa* var. *lushii* (Grah) Hook f. was reported from Kanara: Kasersai jungle, which was part of the Presidency of Bombay but has never been part of Gujarat State. In the FLORA OF GUJARAT STATE, *C. bulbosa* Roxb. is described till the species level and there is no mention of its varieties. Kachhch, from where the authors have collected *Ceropegia*, has never been part of Bombay Presidency. The present compilation is thus the first report of *C. bulbosa* var. *bulbosa* Hook f. and *C. bulbosa* var. *lushii* (Grah) Hook f. from Gujarat State.

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14. AN ANNUAL FLOWERING POPULATION OF NEELAKURINJI *STROBILANTHES KUNTHIANUS* (NEES) T. ANDERS. – A PLIETESIAL SPECIES FROM THE NILGIRI SHOLAS, INDIA

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Strobilanthes kunthianus (Nees) T. Anders. (Family Acanthaceae) is an endemic undershrub that grows above 1,800 m in the sholas of the Western Ghats (Jomy 2008). Plants that bloom at long intervals like Neelakurinji are called plietesials. Bremekamp (1944) used the term plietesial in reference to perennial monocarpic plants. Plietesial life history includes: gregarious flowering, seed setting, and supra-annual synchronized semelparity. Sharma *et al.* (2008) commenting on reproductive ecology reported that this species is semelparous or monocarpic, which means that it can flower once in a life time and die.

The Indian subcontinent is home to nearly 150 species of *Strobilanthes* of which 59 are seen in peninsular India, and of these, 39 are endemic to the Peninsula (Venu 2006). *S. kunthianus* is a small undershrub reaching a height of 30 to 60 cm; it can grow well beyond 180 cm under congenial conditions. This plant is an important understorey component of tropical evergreen forest (Bhat and Murali 2001). Considerable variation in the life history and mass-flowering of *Strobilanthes* has been reported (Wood 1994). Generally, *Strobilanthes* spp. take between 10–15 years (usually 12; rarely 4–9 year cycles have also been seen) to flower gregariously. Mass flowering (covering all individuals) is extremely rare, and flowering of some plants in non-mass flowering years is not uncommon.

The Nilgiris, which literally means Blue Mountains, got its name from the purplish-blue flowers of Neelakurinji that blossoms gregariously on the slopes. It is generally believed that Neelakurinji blossoms only once in 12 years (Anitha and Prasad 2007). The last mass flowering in the Nilgiris was reported in 2005. In 2006, after a gap of 12 years, Neelakurinji flowered in other parts of Tamil Nadu and Kerala (Ian 2006). Neelakurinji once used to cover the Nilgiri hills like a blue carpet during its flowering season. Large parts of the Nilgiris are now occupied by tea plantations and dwellings (Ranjit 2003).

This communication reports observations on annual flowering of Neelakurinji in a shola forest (11° 24' 25.80" N, 76° 43' 18.34" E; 2,410 m) near Doddabetta peak in the Nilgiri hills (Fig. 1). Eight flowering individuals of the fifteen in the study area were studied for flowering phenology for three years. It was found that the same plants blossomed in October 2009 and again in September 2010. Variations in flowering phenology have been reported in other species of *Strobilanthes* and allied genera (Daniel 2006). Wood (1994) observed that *S. wallichii* flowers annually in eastern Himalaya and plietesially in western Himalaya. Robinson (1935) noted a 12-year plietesial cycle for *S. consanguineus*, while Bowden (1950) suggested that this species flowers every year.

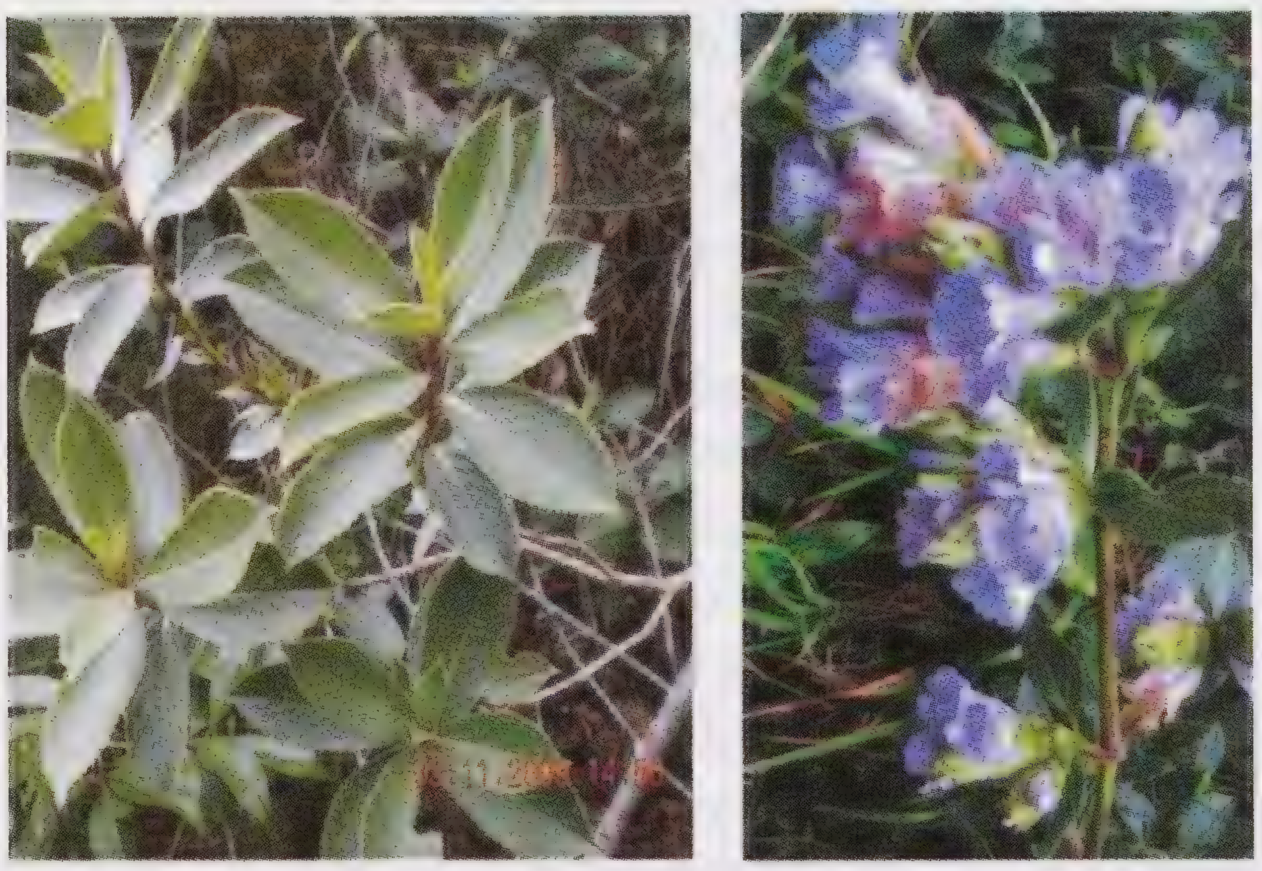

Fig. 1: Non-flowering and flowering plants of Neelakurinji

In contrast to the cases discussed above, I recorded both annual flowering and non-flowering populations in the same area. Moreover, contrary to the general belief that the plant dies after flowering, I observed that not only the plant but even the flowering branch does not die after flowering, and flowering was observed on the same branch in the subsequent year. These findings indicate that the life history of plietesial taxa is not well understood. Janzen (1976) suggested that timing of reproduction in plietesials is set by an internal physiological calendar rather than by external weather cues, which could explain the isolated cases of flowering of *Strobilanthes kunthianus* recorded by me in the Nilgiris. Or it is associated with the local climatic and edaphic factors?

ACKNOWLEDGEMENTS

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15. REDISCOVERY OF *CINNAMOMUM TRAVANCORICUM* GAMBLE (LAURACEAE) FROM THE SOUTHERN WESTERN GHATS, INDIA

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Introduction

The genus *Cinnamomum* Schaeffer with about 250 species is distributed from Southeast Asia to Australia (Mabberley 1990). Of the 16 species reported from southern India, 14 are endemic to the region (Kostermans 1983; Manilal and Shailaja 1986; Mohanan and Henry 1991; Santhosh *et al.* 2003), one of these being *Cinnamomum travancoricum*.

The species was described by J.S. Gamble based on T.F. Bourdillon's collections from Chemunji (=Chemunjee) near Ponmudi in the erstwhile Travancore state in 1895. Chemunji hill (1,717 m) is the second highest peak in the Agasthyamala Biosphere Reserve, next to Agastyarkoodam (1,865 m), the type locality of this species is considered as part of India's biodiversity hotspots. Bourdillon had commented that *C. travancoricum* is a small tree common at higher elevations in the evergreen forests of Travancore. However, repeated search by several flora workers in the type locality proved futile, and hence the species was treated under the Vulnerable category (Nayar 1996; Vajravelu and Daniel 1983). In this paper, we discuss and describe our collection, obtained from the Munnar area of Idukki district, Kerala, after a gap of 113 years. Perusal of literature reveals that Bourdillon's specimen was the only known collection of this species and Chemunji near Ponmudi the only known locality (Kostermans 1983). The present finding of this species from Munnar, which is about 250 km north of the type locality, is significant from both the phytogeographical and conservation point of view.

Cinnamomum travancoricum Gamble in Kew Bull. 1925: 128. 1925 & in Fl. Pres. Madras 1224. 1925; Bor, Man. Ind. For. Bot. 52, 1953; Kostermans, Bibl. Laur. 358. 1964 & in Bull. Bot. Surv. India 119. 1983. (Fig. 1)

Tree, 5–6 m tall. Bark and leaves aromatic. Branchlets slender, angular, densely appressed pilose when young. Leaves opposite or sub-opposite, 7.5–12 x 3–6.5 cm, ovate or broadly ovate, elliptic or subovate elliptic, acute or shortly acuminate at apex, acute at base, thinly coriaceous, smooth, glossy; 3- basal nerves are thin, reaching below the acumen of leaves, prominulous in their basal part, impressed above, densely sericeous hairy when young, glabrous at maturity, secondary nerves prominent, parallel; petioles slender, up to 1.5 cm long. Racemes axillary and pseudo terminal, 3–9 cm long, light brown, sub-appressed pubescent, peduncles slender, densely tomentose; pedicels thick, up to 1–2 mm long, sub-obconical. Flowers 3–5 per raceme, rarely up to 12 by the proliferation of peduncle. Perianth tube funnel-shaped, 1 mm long. Tepals up to 4 mm long, oblong, acute, densely and sub-appressed brown pilose, appressed pilose within. Stamens 2.2–3 mm long, elliptic; anthers 4-celled, the filaments pilose; glands large, attached to the basal part of the filament; staminodes up to 2 mm long, upper part sagittate, stipe pilose. Ovary ovoid, 1.7 mm long, glabrous; style as long as ovary; stigma large, peltate. Fruits not seen.

Flowering: November–March.

Distribution: Endemic to the southern Western Ghats.

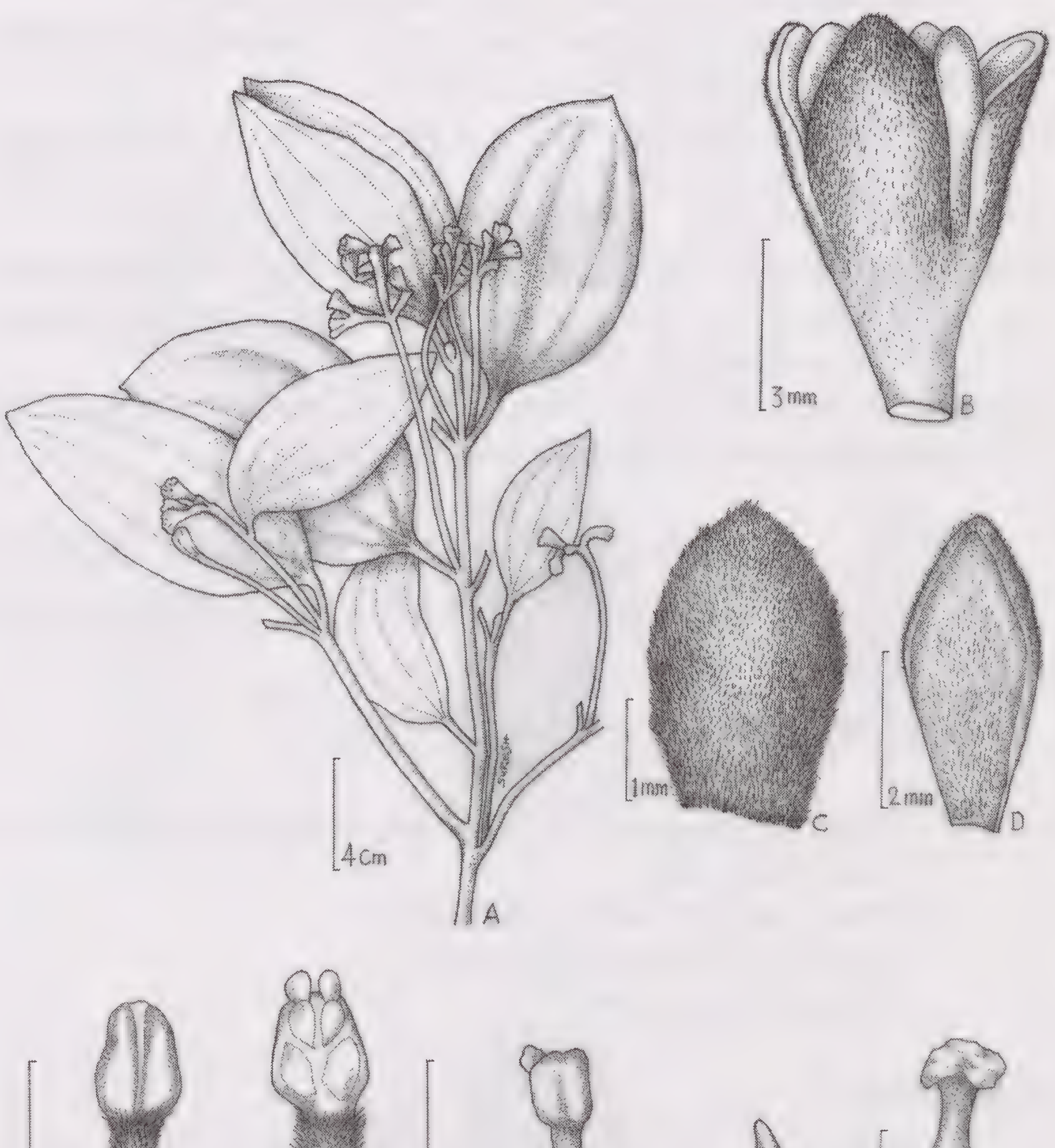

Fig. 1: *Cinnamomum travancoricum* Gamble, a. Twig; b. Flower; c. Outer perianth (outer view); d. Outer perianth (inner view); e.–g. Stamens; h. Staminode; i. Pistil

Habitat and Ecology: The species is found in the shola forests of Munnar in Idukki district, Kerala at an altitude of 2,000 m. The associated species in the community are *Cryptocarya anamalayana*, *Phoebe wightii*, *Vernonia arborea*, and *Symplocos laurina*.

C. travancoricum is apparently similar to or even confused with *C. sulphuratum* at a glance. This may be the reason for workers to erroneously treat *C. sulphuratum* Nees as *C. travancoricum* Gamble in their respective floras (Mohanan and Henry 1994; Ramachandran and Nair 1988). Mohanan and Sivadasan (2002) treated *C. filipedicellatum* Kosterm. collected from Athirumala as *C. travancoricum* Gamble by oversight. On close observation these species can be differentiated by the differences in leaf shapes, ending of lateral nerves to leaf apex, and inflorescence, and can be distinguished by the following key.

1a. Leaves ovate or linear lanceolate; lateral nerves not reaching the apex of leaves, raceme axillary or pseudoterminal 2
1b. Leaves ovate-elliptic to lanceolate elliptic to elliptic; the basal lateral nerves reaching the apex of the leaves; panicle always in the axils of terminal leaves .... *C. sulphuratum*
2a. Young leaves sericeous beneath; peduncle 3–7cm long, stout, 3–5 flowered .... *C. travancoricum*
2b. Young leaves glabrous beneath, peduncle 3–3.5 cm long, slender, 3–9 flowered .... *C. filipedicellatum*

Specimens Examined: Kerala: Idukki district, Munnar, ±2,000 m, 20.ii.2006, fl., Geethakumary & A.G. Pandurangan 48491 (TBGT); Travancore, Chemunji near Ponmudi, alt. 1,200 m. Apr., fl., Bourdillon 545 (TBGT).

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16. TWO NEW RECORDS OF MOSSES FOR THE INDIAN MAINLAND FROM THE AGASTHYAMALAI BIOSPHERE RESERVE IN THE WESTERN GHATS, INDIA

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Introduction

Studies on the bryoflora of the Agasthyamalai Biosphere Reserve were first initiated about a decade ago by the senior author (Daniels 2003). Among the work done, Daniels and Daniel (2004) added the liverwort *Leptolejeunea balansae* to the Indian mainland, and subsequently, the mosses *Calymperes motleyi*, *Fissidens robinsonii*, *Leucophanes glaucescens*, and *L. nicobaricum* (Daniels and Daniel 2005).

In this paper, we report the occurrence of two mosses, *Taxithelium vernieri* and *Trichosteleum punctipapillosum*, earlier known to be distributed only in the Andaman and Nicobar Islands in India, in the Indian mainland from the Agasthyamalai region of the Western Ghats. Each of these species is provided with the correct name, basionym/

synonyms, if any, a detailed description, notes on the habitat and distribution and an illustration. Specimens cited are deposited at SCCN (Herbarium, Botany Department, Scott Christian College, Nagercoil).

Taxithelium vernieri (Duby) Besch., Bull. Soc. Bot. France 45: 123. 1898; Gangulee, Moss. E. India 8: 1922, f. 985. 1980; Vohra & Kar, Bull. Bot. Surv. India 38: 58. 1996; J. Lal, Checklist Indian Moss.: 130. 2005. *Hypnum vernieri* Duby, Flora 58: 285. 1875. Type: Tahiti Isl., *D. Vernier* (PC?). *Trichosteleum lindbergii* A. Jaeger, Ber. Thätigk. St. Gallischen Naturwiss. Ges.: 412. 1878. *T. vernieri* (Duby) A. Jaeger, Ber. Thätigk. St. Gallischen Naturwiss. Ges.: 414. 1878. *Isopterygium lindbergii* A. Jaeger, Ber. Thätigk. St. Gallischen Naturwiss. Ges.: 433. 1878. *Taxithelium lindbergii* (A. Jaeger) Renauld & Cardot, Rev. Bryol. 28: 111. 1901; Bruehl, Rec. Bot. Surv. India 13(1): 107. 1931. (Fig. 1).

Plants corticolous, forming tufts, delicate, glossy, pale green. Stem creeping, 2–6 cm long, pinnately branched. Leaves spreading, concave, ovate-lanceolate, 1–1.3 x 0.2–0.4 mm, revolute on one side at base, toothed at margin for 2/3 above, faintly deflexed and acute at apex, ecostate; cells linear, papillate at tip, sometimes with a few, fine papillae in a row in lumen; apical cells 8–48 x 4–8 µm; median ones 60–100 x 4–6 µm; basal ones 12–40 x 4–8 µm; alar cells quadrate, 20–32 x 8–12 µm, hyaline. Sporophyte not seen.

Habitat: Corticolous on *Syzigium* sp. and terricolous, in evergreen forests, *c*. 820 m.

Distribution: Southeast Asia and India (Nicobar Islands and W. Ghats of Tamil Nadu).

Specimens Examined: Western Ghats, Tamil Nadu, Kanyakumari dist., Seafield, *c*. 820 m, 18.xi.2008, A.E.D. Daniels & J.L. Mabel 86, 94.

Trichosteleum punctipapillosum Paris [Index Bryol.: 1314. 1898, nom. nud.] ex Gangulee, Moss. E. India 3(8): 1913, f. 980. 1980. J. Lal, Checklist Indian Moss.: 138. 2005. Type: India, Andamans, Port Blair, 1892, *Man s.n.* Herb. Levier. 483 (BM). *Hypnum punctipapillosum* Müll. Hal. in Paris, Index Bryol.: 1314. 1898, nom. nud. (Fig. 2).

Plants monoecious, forming mats, glossy, yellow-green. Stem creeping, 0.5–2 cm long; branches pinnate, 3–8 mm high. Leaves imbricate, erectopatent, concave, 0.9–1.2 x 0.4–0.6 mm, ovate-lanceolate, crenulate at margin, acute and faintly toothed at apex, ecostate; apical cells 28–42 x 4–6 mm, narrow, rhomboid, elongate, papillate on cell tip;

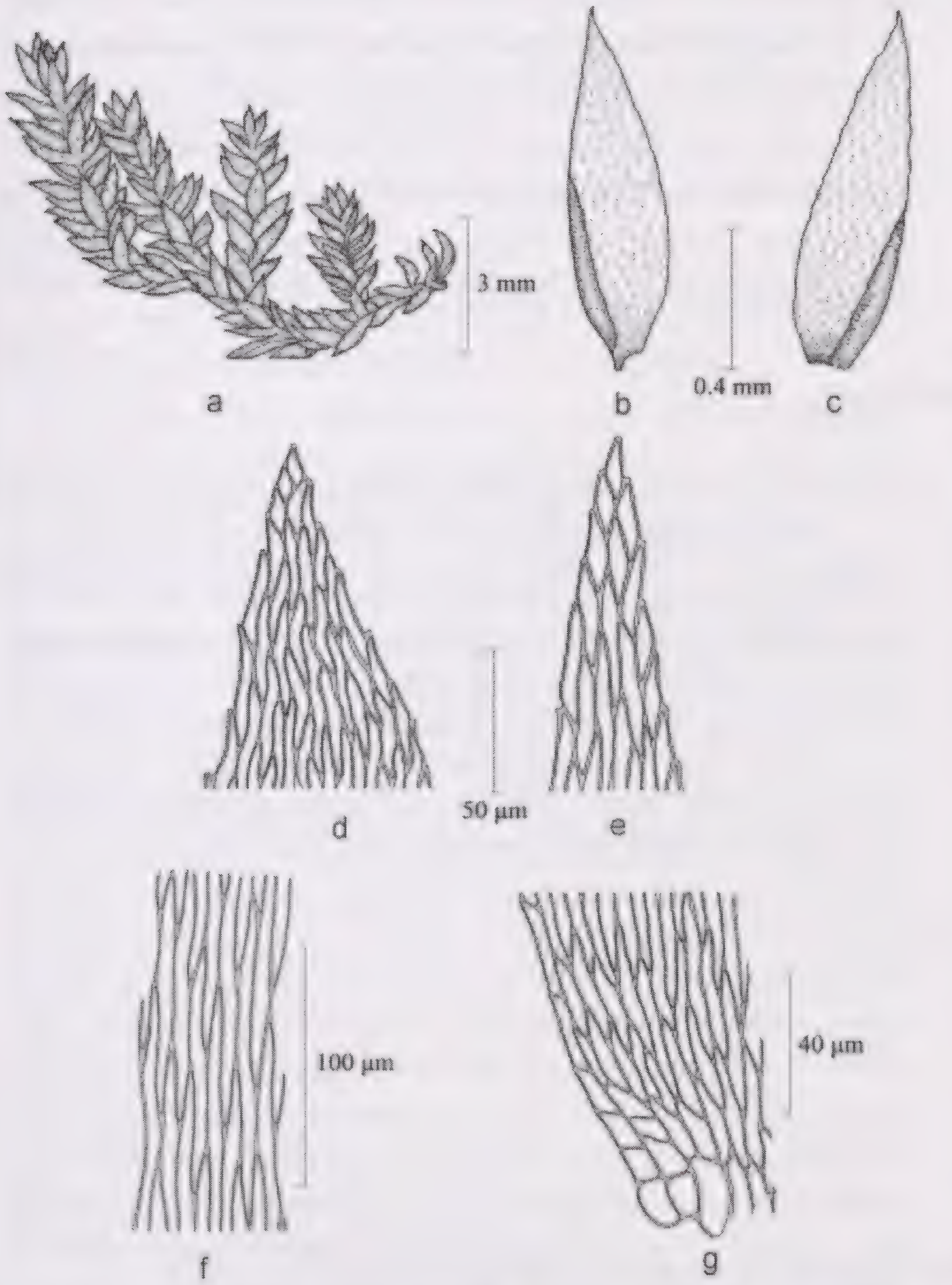

Fig. 1: *Taxithelium vernieri* (Duby) Besch.: a. Habit, b.–c. Leaves, d.–e. Leaf apical cells, f. Leaf median cells, g. Leaf basal cells

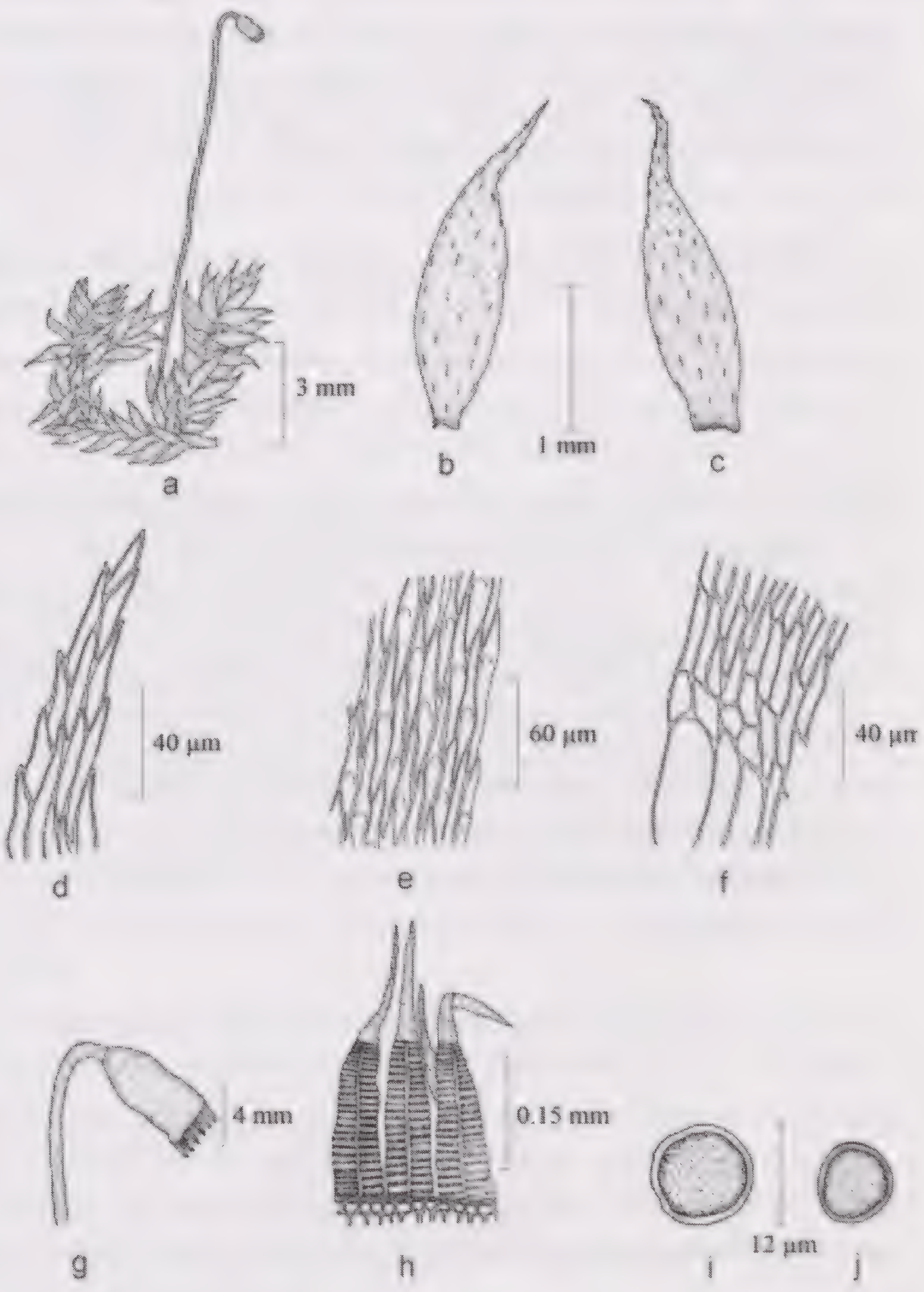

Fig. 2: *Trichosteleum punctipapillosum* Paris ex Gangulee: a. Habit, b.–c. Leaves, d. Leaf apical cells, e. Leaf median cells, f. Leaf basal cells, g. Capsule, h. Peristome teeth, i.–j. Spores

median ones 52–64 x 4–8 mm, rhomboid, elongate, with papillae in centre and tip; alar region with 3, inflated, oblong, 54–68 x 16–32 mm hyaline cells, with a few smaller, 12–48 x 4–12 mm irregular ones above them. Sporophytes on main stem. Setae *c.* 1 cm high, erect, slender, faintly papillose above. Capsules horizontal to drooping, *c.* 0.65 x 0.4 mm, ovoid. Peristome teeth 2-tiered, *c.* 240–320 x 40–48 mm; outer tier horizontally striate, papillose towards apex; inner tier membranous, segmented, faintly horizontally striolate, papillose throughout. Spores 8–12 x 8 –11 mm globose, faintly papillose, pale brown.

Habitat: Corticolous on *Elaeocarpus venustus* Bedd. in evergreen forests, *c.* 1,100 m.

Distribution: India: Andaman Islands and W. Ghats of Tamil Nadu.

Specimens Examined: Tamil Nadu, Kanyakumari dist., W. Ghats, Muthukuzhivayal, *c.* 1,100 m, 31.iii.2009, A.E.D. Daniels & J.L. Mabel 268.

Discussion

Taxithelium vernieri can be readily distinguished from *T. kerianum* (Broth.) Broth. and *T. nepalense* (Schwägr.) Broth. by the presence of unipapillate leaf cells against the seriate-papillate ones present in the latter two. *Taxithelium laeviusculum* Dixon, a closely allied species, differs from *T. vernieri* in possessing a single papilla in the centre of the leaf cells, whereas the latter has it at cell apex.

Trichosteleum punctipapillosum can be readily distinguished from *T. boschii* (Dozy & Molk.) A. Jaeger, *T. glaucovirens* (Mitt.) Broth., *T. hamatum* (Dozy & Molk.) A. Jaeger and *T. luxurians* (Dozy & Molk.) Broth. in the absence of a row of oblong, tinted cells at leaf attachment with a few cells at alar region inflated, whereas in *T. punctipapillosum*, the alar region is differentiated by 3 inflated, oblong, hyaline cells. *Trichosteleum stereodentoides* Broth. ex Gangulee, which has the same feature, can be distinguished from the former by the presence of pluripapillate cells at midleaf. *Trichosteleum stissophyllum* (Hampe) A. Jaeger, a very closely allied species, differs from *T. punctipapillosum* in having unipapillate leaf cells and only 2 inflated cells at the alar region which are tinted. *Trichosteleum luxurians* and *T. stissophyllum* are now *Papillidiopsis luxurians* (Dozy & Molk.) W.R. Buck & B.C. Tan (*vide* Buck & Tan, 1990) and *P. stissophylla* (Hampe) B.C. Tan & Y. Jia (*vide* Tan & Yu, 1999) respectively, and *Trichosteleum hamatum* is *Radulina hamata* (Dozy & Molk.) W.R. Buck & B.C. Tan (*vide* Buck & Tan, *l.c.*).

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Species names should carry the Author's name and subspecies (trinomials) should only be used where identification has been authentically established by comparison of specimens actually collected.

For the standardised common and scientific names of the birds of the Indian subcontinent refer to *Buceros* Vol. 6, No. 1 (2001).

Miscellaneous Notes: The section accommodates incidental observations on flora and fauna of the Asian region, and need not follow strictly the above section headings. No abstract is required, but key words may be included and references must be cited as in the rest of the *Journal*.

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CONTENTS

EDITORIAL 1
LION AND CHEETAH IN INDIA: A CRITIQUE
Divyabhanusinh and M.K. Ranjitsinh 3
BEHAVIOURAL ETHOGRAM OF THE GREAT INDIAN BUSTARD *ARDEOTIS NIGRICEPS* (VIGORS 1831)
Pramod Patil, Asad R. Rahmani and Sara Hallager 22
BIRD RECORDS FROM TAWANG DISTRICT, ARUNACHAL PRADESH, INDIA
Gopinathan Maheswaran 35
DIVERSITY AND DISTRIBUTION OF ACRIDID PESTS (ORTHOPTERA: ACRIDIDAE) OF PURVANCHAL REGION, UTTAR PRADESH, INDIA
Uzma Rafi and Mohd Kamil Usmani 50
FLORISTIC DIVERSITY OF THE KUNJAPURI SACRED GROVE, GARHWAL HIMALAYA, INDIA
Megha Rawat, H.B. Vasistha, R.K. Manhas and Mridula Negi 57

NEW DESCRIPTION

A NEW SPECIES OF *NOTASPIDIELLA* BOUČEK (HYMENOPTERA: CHALCIDIDAE) WITH A KEY TO SPECIES AND NOTES ON KNOWN SPECIES
T.C. Narendran, Abhilash Peter, K. Nikhil and Minu Mohan 65

MISCELLANEOUS NOTES 71

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VOLUME 110(2): AUGUST 2013

CONTENTS

EDITORIAL 93

RESPONSE TO THE REVIEW OF EXOTIC ALIENS FROM ROMILA THAPAR, YUSUF ANSARI, AND VALMIK THAPAR
Valmik Thapar, Romila Thapar and Yusuf Ansari 95

EXOTIC ALIENS – LION AND CHEETAH IN INDIA: A REJOINDER TO AUTHORS' RESPONSE TO OUR REVIEW
M.K. Ranjitsinh and Divyabhanusinh 105

THE "EXOTIC ALIENS" CONTROVERSY: A VIEW FROM AFAR
Stephen J. O'Brien 108

THE MAMMALS OF SRIHARIKOTA ISLAND, SOUTHERN INDIA, WITH INSIGHTS INTO THEIR STATUS, POPULATION, AND DISTRIBUTION
Ranjit Manakadan, S. Sivakumar, Patrick David and B. Senthil Murugan 114

DIVERSITY AND ABUNDANCE OF RODENTS IN THE SEMI-ARID LANDSCAPE OF SARISKA TIGER RESERVE, WESTERN INDIA
Shilpi Gupta, Krishnendu Mondal, K. Sankar and Qamar Qureshi 122

THE STATUS OF THE GANGES RIVER DOLPHIN *PLATANISTA GANGETICA GANGETICA* IN THE RIVER BARAK, ASSAM, INDIA
Th. P. Singha, B.K. Dutta and S.P. Biswas 129

PTERIDOPHYTIC DIVERSITY OF BAROT, MANDI DISTRICT, HIMACHAL PRADESH, INDIA
Alka Kumari, Brij Lal and Om Prakash 135

TERRITORIALITY IN KERALA LAUGHINGTHRUSH *STROPHOCINCLA FAIRBANKI MERIDIONALIS*
Vivek Chandran A. and Praveen J. 142

REVIEWS

1. BIRDS OF CENTRAL ASIA
Reviewed by Ranjit Manakadan 147

2. ELEPHANT – THE LADY BOSS: ECOLOGY AND MANAGEMENT
Reviewed by Ranjit Manakadan 147

3. ROMANCING THE ELEPHANT – A STRATEGY TO MITIGATE HUMAN-ELEPHANT CONFLICT
Reviewed by Ranjit Manakadan 148

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MISCELLANEOUS NOTES

MAMMALS

1. The Hoolock Gibbon *Hoolock hoolock* in Saiha, Mizoram, India: Historical records, recent sightings, and conservation issues
Nimesh Ved 149

2. Records of the melanistic Leopard *Panthera pardus* (Linnaeus) from Western Ghats area of Maharashtra and Karnataka, India
Amit Sayyed, Saurabh Takalkar and Anil Mahabal 151

3. Lesser Dawn Bat *Eonycteris spelaea*: the first record for Bangladesh
M. Monirul H. Khan 152

4. Reappearance of the Wild Pig *Sus scrofa cristatus* in Dachigam National Park, Kashmir, India
Khursheed Ahmad, Parag Nigam, Bilal Habib, M. Sadiq Mir, Zaffar Rais, Mehraj-u-Din Shah and N.A. Malik 153

BIRDS

5. Record of the Great White Pelican *Pelecanus onocrotalus* in Mysore, Karnataka, India
M.K. Sapthagirish and Honnavalli N. Kumara 154

6. Sighting of Long-tailed Duck *Clangula hyemalis* in Gharana wetland, Jammu & Kashmir, India
Guldev Raj 155

REPTILES

7. Banded Krait *Bungarus fasciatus* feeding on Common Krait *Bungarus caeruleus*
Arun M.K. Bharos 155

FISH

8. Marine ornamental ichthyofauna of Thoothukudi coast, Gulf of Mannar, India
P. Jawahar, G. Brucelee and T. Umamaheswari 156

AMPHIBIANS

9. Khare's Stream Frog *Pterorana khare* – a new record for Bangladesh
M. Monirul H. Khan 162

OTHER INVERTEBRATES

10. On a record of *Rhynchocinetes durbanensis* Gordon, 1936 (Decapoda, Caridea, Rhynchocinetidae) in the Gulf of Mannar, Tamil Nadu, India
Sanjeevi Prakash and Thipramalai Thangappan Ajith Kumar 163

BOTANY

11. *Closterium tortitaenioides* Coesel – an interesting new alga to the Asian continent
Jose John and M.S. Francis 165

12. *Bhesa robusta* (Roxb.) Ding Hou, Celastraceae: a new distributional record from Tripura, India
Koushik Majumdar, B.K. Datta and Uma Shankar 166

13. *Dopatrium junceum* (Roxb.) Buch.-Ham. ex Benth. – a new record for the flora of Tripura, India
Somnath Bhowmik and B.K. Datta 168

14. Range extension for critically endangered plant, *Crinum woodrowii* Baker
Jui Pethe and Amit Tillu 169

Cover Photograph: Great Pied Hornbill *Buceros bicornis*
By Mohan Thomas

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Editorial

Asiatic Lion: Reintroduction or Assisted Dispersal?

Reintroduction has been recognised all over the world as one of the ultimate forms of conservation action as it involves a large number of conservation steps. The International Union for Conservation of Nature and Natural Resources (IUCN) has a very active Reintroduction Specialist Group that advises and monitors reintroduction programmes. IUCN (www.iucn.org) has prepared Reintroduction Guidelines that are regularly updated as conservation science develops. There are strict protocols to be followed before, during, and after the reintroduction of a species.

Reintroduction, and in some cases introduction, is done when natural colonisation by a species is not possible, the factors that exterminated the species from a particular area are effectively removed, and habitat has been restored to receive the species. As reintroduction involves a long-term commitment, it is generally done by the government with the help of experts. It also involves long-term planning and removal of all those factors that had originally exterminated the species from the area. Reintroduction is one of the finest forms of human values – in that we want to rectify earlier mistakes and restore the natural balance.

Species are reintroduced to their earlier distribution range when it is not possible for them to colonise naturally due to human-created barriers. If they can re-colonise the habitat on their own, reintroduction is not required – we just have to restore the habitat and wait for re-colonisation to happen. This is possible when corridors are intact or the species is very mobile, for example, birds. Even many birds have been reintroduced or introduced to similar habitat (in case the original habitat is totally destroyed).

There are hundreds of examples in the world where locally exterminated species have been reintroduced successfully. I suggest that readers visit Reintroduction Specialist Group website of IUCN (IUCN/SSC 2013). Arabian Oryx *Oryx leucoryx* became extinct in 1973 due to excessive hunting. Oman was the first range country to ban its hunting and brought back this iconic animal to its former habitat (Price 1989), followed by Saudi Arabia where the first reintroduction of Arabian Oryx was started in 1989 in a fenced protected area called Mahazat as-Sayd Protected Area (2,400 sq. km) in central Saudi Arabia. In 1995, a number of Arabian Oryx were reintroduced in Rub al Khali or Empty Quarter (without fence). Both the areas now have significant self-sustaining breeding populations (Islam *et al.* 2011). Przewalski's Horse *Equus ferus przewalskii* is another good example of reintroduction of a large mammal. It was declared extinct in the wild in the 1960s, but fortunately some animals were present in western zoos where they were bred meticulously. In the 1980s, 11 were transferred from western zoos to the Wild Horse Breeding Centre (WHBC) in Xinjiang, China, where a captive population of more than 150 horses was eventually established. In 2001, 55 were reintroduced to the 1.7 million hectare Kalameili Nature Reserve. These are two examples of conservation breeding and successful reintroduction. Closer to home, we have a good example of the reintroduction of Tiger in Sariska (Rajasthan) and Panna (Madhya Pradesh). Tiger reintroduction in Panna is quite successful and in approximately six years, the tiger population has increased to more than 25.

There are many examples of 'wild to wild' introduction: a species is still present in the wild, a small number are caught and released in their former range which has been prepared in advance for receiving them, as the Government of India wants to do for the Asiatic Lion in Kuno-Palpur Wildlife Sanctuary of Madhya Pradesh. The Asiatic Lion *Panthera leo persica* was once widely distributed from the Middle East to Persia to India. Excessive hunting almost exterminated it, except for a small population left in the Gir forest of Saurashtra, Gujarat that was meticulously protected by the Nawab of Junagadh (Divyabhanusinh 2005). After Independence, the Government of Bombay Presidency and later the Government of Gujarat played a stellar role in protecting the animals so much so that it has now become the 'pride of Gujarat', with very few cases of Lion poaching by locals. From a small population of a few dozen individuals hiding in the 1,400 sq. km jungles of Gir, the Asiatic Lion has now spread out to nearly 40,000 sq. km, some prides living in *Prosopis* thickets near villages: the last official count of 2010 shows that there could be 411 lions, spread across Junagadh, Amreli, and Bhavnagar districts. They are now found in the coastal areas (Una, Kodinar, Sutrapada, and Chhara) and Savarkundla, Liliya, and adjoining areas of Amreli and Bhavnagar districts. According to the last census, about 64 Asiatic Lions are found in these areas. This natural spread is due to the fact that the Gir forest cannot hold more lions, and secondly there was no barrier, physical or social, to prevent the dispersal of lions in Saurashtra. This is a case of natural dispersal of a species to its former range.

During the last 20 years, the Madhya Pradesh government has prepared Kuno-Palpur Wildlife Sanctuary to receive Asiatic Lion, so that a second home can be developed for this species. There are two major reasons: first, to reintroduce the species in its former range, and secondly to act as a secure gene pool in the event of an epidemic spreading in the Gir region which could wipe out most of the population It makes perfect conservation sense to spread the species widely and develop smaller populations in the former range of the Asiatic Lion. But, we have a problem here.

A few local conservationists have convinced the Gujarat government not to allow transfer of even a small pride of 8–10 Asiatic Lions living outside the Gir Forests to Kuno-Palpur (or anywhere outside Gujarat). Their argument is based on emotions, not on science, but let us see what they say.

First, the people of Gujarat have been protecting the Asiatic Lion extremely well, so there is no need to transfer some of them to an area where they may not remain protected. No doubt, the people and government of Gujarat have been protecting the Asiatic Lion well, but this is not a strong argument to oppose taking a pride that is living on the fringe (please remember, no Lion from the Gir forest will be taken) to reintroduce to Kuno-Palpur which has been very well protected by the Madhya Pradesh Forest Department to receive the species. There is abundant prey and habitat for the Asiatic Lion in Kuno-Palpur. Each Lion will be radio-tagged to follow its movement, so the chances of poaching will be reduced. All the Guidelines of IUCN and Government of India have been and will be followed by the Madhya Pradesh government. Successful transfer of One-horned Rhinoceros from Assam to Dudhwa National Park in 1984 is a classical case of reintroduction of a species in its former range. The Uttar Pradesh Forest Department needs to be congratulated that not a single rhino has been poached from Dudhwa till now. Why would it be different in Madhya Pradesh when such high stakes are involved?

The second argument is that the earlier reintroduction experiment of Asiatic Lion in Chandraprabha Wildlife Sanctuary (96 sq. km) in 1959 failed, therefore, this experiment will also not succeed. India has a come a long way since the 1950s, and conservation science is now well-developed, so the chances of failure in Kuno-Palpur are minimal. Moreover, one failure does not mean that we should not try again. Science cannot develop if we stop experimenting and trying.

The third argument put forward by some local conservationists of Saurashtra is that Kuno-Palpur is a tiger habitat and lions and tigers cannot live together. This argument has no scientific basis. Even a few hundred years ago, when Asiatic Lion and Tiger were more widespread in India, there must have been many areas where both were living in the same forest, maybe in different ecological niches. Animals have their own ways of spatial and temporal separation. Even three or four large carnivores can live in the same area, maybe eating the same prey but avoiding each other through time and space. Serengeti in Africa is a well-known example where the African Lion, African Cheetah, and Leopard can be found in the same area, but avoiding each other. Two other major carnivores are also found there: Hyena and African Wild Dog. In the past, when large natural areas were intact in India, the Asiatic Lion, Bengal Tiger, Asiatic Cheetah, Leopard, and Wild Dog or Dhole would have been sharing the same landscape.

In conclusion, we assert that there is no scientific basis for opposing the reintroduction of Asiatic Lion in Kuno-Palpur Wildlife Sanctuary (or any other area which is made suitable to them), by transferring 8–10 animals initially, and a few later if the need arises.

The Gujarat government and Gujarati people need to be praised for protection of Wild Ass, so much so that the species is even attempting to colonise its former range in neighbouring Rajasthan (Sangha 2003). This re-colonisation is possible only because the Wild Ass habitat and corridors are still intact, while in the case of Asiatic Lion there is no corridor left between Saurashtra and Kuno-Palpur. Can we create this 'corridor' by lifting a few Asiatic Lions from Saurashtra and taking them to Kuno-Palpur? I call this human-assisted dispersal. We have been doing this for many species, so why not for the Asiatic Lion? Weren't tigers reintroduced in the isolated Sariska Reserve where natural colonisation was not possible due to lack of corridors? If we follow the argument that a species belongs to a state as it has protected it well, will the Government of Gujarat stop the Wild Asses from recolonising their former range in Rajasthan? Actually it should be a pride of any state to give its animals to other states so they can flourish in more areas. Giving is a part of our Indian culture, which some people appear to have forgotten.

Asad R. Rahmani

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RESPONSE TO THE REVIEW OF EXOTIC ALIENS FROM ROMILA THAPAR, YUSUF ANSARI, AND VALMIK THAPAR

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This is a response to the review of EXOTIC ALIENS: THE LION AND THE CHEETAH IN INDIA, carried in the *Journal of the Bombay Natural History Society*, No. 110(1), dated January–April 2013. The book is written by Valmik Thapar with chapters by Romila Thapar and Yusuf Ansari. The review under discussion here is by Divyabhanusinh and M.K. Ranjitsinh. It is a long-winded review that will be responded to by each of the authors.

PROFESSOR ROMILA THAPAR

On the meaning of the title, the dictionary meaning of *exotic* refers to that which is not indigenous and adds that it is unusual and interesting; and *alien* refers to that which comes from a different place. In neither case is the primary meaning derogatory, nor does it reflect the unimportance of what is described as exotic and alien. These latter meanings given by the reviewers, change the focus of what is being argued in the book.

In the criticism of Chapter One, may I say that even though I wrote it in as simple a manner as possible, my argument has been given an emphasis that is not there in the original. Perhaps the reviewers are unaware that arguments are not made only in black-and-white terms and that there are large areas of grey in every field of knowledge. The intention of the book was to raise questions about certain species of animals being either indigenous or not so, to India. Even though there was no definitive answer for all periods of time, it was perhaps worthwhile to raise the questions.

My chapter was intended as a historical overview of early periods and therefore I went step by step, chronologically. But this review is historically unsystematic. It jumps back and forth over a span of even thirty centuries and makes historical comparisons that show little control over the data. This is surprising coming from reviewers who presumably understand the systematic procedures of research in the natural sciences. Nevertheless I will go through it in the order in which the arguments are made in the review.

Page 4

The reviewers state that because the Indian subcontinent was at the extreme distributional end of their faunal range that originated from Africa, it is likely that the cheetah and the lion did not attain a high degree of abundance in India. If this was so, its non-application to the western and southern extremities of the faunal range needs an explanation. The question asked in the chapter does not relate to the degree of abundance in India but as to when the lion and cheetah became a normal part of the Indian landscape.

The reviewers are incorrect in saying that the Harappan and Vedic civilisations "occupied and cultivated the same short grasslands and the open forest areas of western and north-western portions of the subcontinent…" The northernmost outpost of the Harappan culture was in the Pamirs, the southernmost in northern Maharashtra, extending westwards to Baluchistan and eastwards to the upper Doab, with settlements in Oman in Arabia. Much of this area was unknown to Vedic civilization. The extent of the Vedic civilization is difficult to map since there are no definitive archaeological equivalents of the culture. But drawing information from the *Rigveda*, the earliest text of the Vedic corpus, it extended from the north-western borderlands, through Punjab and into the fringes of the Doab. From this area it moved to the Ganges plain but not into western India. Western India does not come onto the Vedic horizon until the mid-first millennium BCE. Only some parts of the river valleys of the north-west and of the Punjab would have had grasslands and open forest under continuous cultivation. Given the demography of the Harappan settlements, the pressure from agriculture would hardly have resulted in the shrinking of the habitat. If at all this happened, it was limited to a relatively small area as compared to the area covered by the Harappa culture, and which areas would have continued to host lions and cheetahs had there been any. This would not have denuded the lion and cheetah of their prey if they had lived in this habitat.

Judging by the sources, the greater frequency of the lion in Persia would have been the area to the north in the Oxus plain. This is a more likely location for entry into north-western India rather than the Makran coast, for which there is also no evidence. The huge numbers of lions hunted and killed, as I have mentioned, are recorded in Egypt and Mesopotamia, where they were hunted partly in hunting parks but also in the wild, as they were in the Oxus plain. The location of lions, therefore, was not limited to Africa. The "mental embargo" is obviously in the minds of those who limit the source to only one place.

Page 5

The sarcasm in the question of whether Alexander's armies transported lions is misplaced. It suggests that the reviewers are unfamiliar with the role of armies in earlier times. As has been well-established by now, one of the results of military campaigns was to strengthen connecting routes between areas, and if need be to forge new ones. Alexander's army was no exception as is evident from the increase in the volume of trade between northern India and west Asia, subsequent to his campaign. These routes were used for carrying items of trade or gifts for presentation. The armies did not transport cargo but the resulting improvement in routes assisted in the transportation of goods of various kinds. That was the argument being made in the book.

Page 5

The Kautilya *Arthashastra* does not refer to lions being imported but it does imply that they were bred in captivity. The text – as I have quoted it – states that in certain parks the teeth and claws of the animals have to be removed, and the list of such animals includes the lion. This could only be done if the lions were bred in captivity. The lions that may have been imported would not have been let loose in the wild but would certainly have inhabited the hunting parks and the areas cordoned off for hunting. Their numbers would be nowhere near those referred to in Egyptian and Mesopotamian sources, as lions killed both in the wild and in hunting parks.

Page 6

The reviewers pose the question that by referring to tigers having an indigenous habitat in India, am I maintaining that India was where they evolved? Does it require a historian to point out to naturalists that the two are not necessarily the same?

The identification of the lion at Bhimbetka is not a definitive identification and that is why it was omitted. There is also a problem with dating rock paintings in India in the absence of associated excavations, and dating methods for rock art remain controversial. The absence of the lion on Harappan seals has been skirted round by the reviewers in their argument that lack of depiction on the seals does not mean that the animal is absent. But the crucial point raised in the chapter is not just the absence of the lion on the seals, but more interestingly, that in the so-called "Gilgamesh scene" there is a near identical representation on a Mesopotamian and a Harappan seal, of a man grappling with two animals, one on each side. In the Mesopotamian version the animals are lions, but in the Harappan version they have been replaced with tigers. The statement this makes is obvious.

The reviewers then proceed to refer to terracotta figurines, coins, sculptures at *stupa* sites and so on, where the lion has been depicted. This is merely a repetition of what I have said in Chapter 1. But what the reviewers do not seem to understand is the chronology of this evidence. I am arguing that the lion arrived in India sometime just before the Mauryan period. Obviously, subsequent to that, it would be depicted in all kinds of ways. So what is the point of stating that it occurs on post-Mauryan objects when that has already been stated in the chapter, and stated in order to suggest that it is a late arrival.

I have said in the chapter that the representation of the lion on the Mauryan pillars is its *earliest* appearance (p. 40). This does not mean that I am saying it is the *only* appearance as the reviewers state. There is a big difference of meaning between the two words. Once the lion becomes the symbol of majesty – as it was in many parts of the ancient world – then its depiction on monuments is to be expected. If one wants to make a comparison with the depiction of the tiger, then it is not just a matter of counting numbers, as one has to consider the context of the object on which the animal is depicted, as well as its authorship and purpose.

Page 7

Another chronological confusion occurs in the review with reference to lions in the *Rigveda*. I am not linking these references to Afghanistan but to the BMAC (Bactria Margiana Archaeological Complex). Small-scale migration from north-eastern Iran or from the BMAC to the Punjab and from there to the Ganges plain, would have taken two or three centuries and certainly not millennia. These are contiguous areas with archaeological settlements. Memories would certainly be handed down in such a short span of time.

With reference to lions in Persia, two well-established references to hunting lions in the wild by Darius and later by Alexander, which I have mentioned, both locate the lions in the Oxus plain. If there were lions to be hunted further south in Iran, it is unlikely that the royal hunt would have gone as far north as Balkh. Alexander had to make a sizeable deviation to take in this hunt. If one is looking at the migration of animals, lions occurred in the wild in Upper Egypt around the Nile delta. They were also found in the land between the

Tigris and Euphrates in Mesopotamia. Was there a migration from here to the Oxus plain or were the latter indigenous to the area? If lions were needed as royal gifts, transportation to north-west India would not have involved crossing high mountains as the reviewers assert. There are multiple river valleys in the region linked through relatively low-elevation passes. This was what encouraged the movement of people and goods over many centuries. Lion cubs would have made very presentable gifts.

Turning to the cheetah, if it existed in the rock art of the Neolithic-Chalcolithic of the third millennium BCE, it does seem odd that there is no evidence of it in the intervening thirty-six centuries to the early second millennium CE. Do species disappear and resurface in such erratic ways after so many centuries? and how should one explain the sudden resurfacing of this animal? Rock paintings from Kharvai and Karad are reproduced and are identified as cheetahs. These depict heavily built animals, almost bovine. The reviewers list what they take to be characteristic marks of the cheetah, but apart from the spots there is little else to specifically recognize them as such. The characteristic of rock art, on the other hand, is that only the most familiar animals are so depicted as to be clearly recognisable. There is a world of difference between the so-called cheetah and the recognisable leopard in the reproductions included with the review.

My reference to Arabs on the western coast of India is questioned. But again, as all students of history know, settlements of Arab traders all along the west coast of India from the eighth-ninth centuries onwards, are well-attested. Arabs working in the administration of the Rashtrakuta rulers are referred to in royal inscriptions. Ships' captains, seamen, and traders from west Asia are present in the settlements all along the west coast of India, handling the huge import of horses into India, together with other kinds of commerce, from the first millennium CE.

Taming animals to hunt is something that goes back to the time when hunting was invented and a range of animals were used. The point that is being made here is the use of a specific animal, the cheetah. This is not referred to in early times.

Page 12

The reviewers disallow trans-shipment from North Africa to the Red Sea and ask disbelievingly if there is any report of this anywhere. Here again there is overwhelming evidence from Greek and Latin texts and from archaeology, of a substantial trade – commonly referred to as the Indo-Roman trade – during the period from the second century BCE to the fifth century CE. Cargo of large dimensions travelled from Alexandria down the Nile to Koptos, from where it was trans-shipped across the desert to the ports of the Red Sea such as Berenike, and then loaded onto ships that sailed with the monsoon wind to the west coast of India, and to ports such as Muziris in Kerala. Cargo from southern Egypt was sent by ship up the Nile to Koptos also for trans-shipment across the seas. This route continued to be used, as also the more northerly route via the Gulf, into the late second millennium CE. The southerly mid-ocean route from east Africa was linked to the 12 degree Latitude, later continued by the Portuguese. There was far more communication in the ancient world than is dreamt of by people today.

I am quoted as having said that Afghanistan was the land of the *Rigveda*. This is not correct (p. 37). However, even if it was, it is utterly anachronistic to compare what is said in two texts 2,500 years apart, the *Rigveda* and that of Guggisburg. This is the kind of casual treatment of historical evidence by non-historians that makes historians despair. Such comparisons are chronologically and historically irrelevant.

Page 16

I am quoted as saying:

"Professor Thapar states categorically that there is no record of lions being traded in the ancient period. The same goes for the cheetah."

A trade in items means a regular flow of a certain item from a source to a commercial outlet. To this extent there was no trade in lions and cheetahs being brought regularly to commercial centres in India. But this does not preclude the sending of lions, cheetahs, and other animals as gifts to those able to look after them in their parks or menageries or whatever. This was the way lions came to Rome, not as part of trade. They were captured in the grasslands, transported to the North African ports, shipped to Rome where they stayed as part of the gladiatorial activity and in circuses. Transporting them was no big deal. But they do not feature as part of big-game hunting in Europe. And we know of them today because there is mention of them in gladiatorial fights and circuses. They could similarly have been transported to India and kept in the hunting parks, as they are known to have been. Their presence was marked although their numbers were few – as in Rome. There being no record of trade, does not mean that no lions could have been brought. Once again let us not underestimate what came and went in times past.

Page 20

The final sentence of the review is a give away. It says, "With the evidence placed forth in this paper, the question would arise as to who is the "imposter", the book EXOTIC ALIENS: or the lion or the cheetah in India. Let the reader decide." Since a book cannot be an imposter, this remark can

YUSUF ANSARI

1. The analysis is based on a presumption that as an historian it is my prejudiced intention to disprove the existence of the lion as an 'Indian species'. That is far from the objective of my study. The aim in both my chapters has been to offer an alternative to accepted schools of thought, which itself is based on sketchy evidence and a misreading or weak translations of historical texts, particularly Persian texts in the Mughal period.

2. A significant premise for calculating the presence of the lion in the Indo-Islamic narrative is the oft misunderstood lack of distinction between the terms *shir* and *babr*, an aspect I have devoted a considerable part of my essays to, but which appears to have been ignored in this critique. In the same vein, one of my earliest posers at what stage does a species become 'naturalised'? And the consequent theme of the naturalisation of species has also been totally cast away in this criticism posing as critique.

3. My narrative, particularly on the gifts of tribute, which included animals of the chase, has also been left aside while a parallel droning for no evidence of imports is sounded through the criticism.

4. Finally, nowhere in my narrative have I in a single instance made any 'denigrating' remarks about a particular species and I would be grateful to the critics of this narrative to point out a single instance that buttresses their charge of 'contrived one-upmanship', anywhere in my piece.

In my mind, the aim of this work was and continues to be an encouragement of debate around the subject of the provenance of the lion and the cheetah. Contrary to the assertions by the critics, at no point have I drawn definite conclusions, only laid out historiographical posers, which question the viability of the accepted view that both species have been indigenous to India. While accusing me of 'selective referencing', the selective analysis of my essays ignores a fundamental thrust of my argument and that is the linguistic confusion pertaining to the classification of big cat species. Most notably the interchangeable use of *sher* for tigers and lions in the Mughal narrative, as a result of which the lines between the two, in historical accounts, have been blurred. This in turn has led to an exaggerated estimate of lion numbers, because more often than not the Mughal *sher* was in fact the tiger, though it was translated to mean the lion.

Furthermore, as a big cat enthusiast with an abiding passion for history there is no question of a disparaging or condescending attitude towards a magnificent creature like a lion or indeed a cheetah, both of which I have observed at close quarters in the wild. The critics have ascribed a prejudiced notion to my motive for being part of this book: the preference for one species over another. I am surprised by this and can only submit that this is not the case. My aim has been to examine the historical record and stir a debate on the subject to contribute to and inform existing perspectives on the matter. From their response, I have the satisfaction of knowing I have succeeded in some measure.

VALMIK THAPAR

As principal author of EXOTIC ALIENS, I am very surprised to have seen a book review of nearly 20 pages devoted to a critique of the abovementioned book. If such a critique is thought to be significant, the normal procedure in serious journals is to send it to the authors of the book for their response, and then both the critique and response are published together. Sadly not only was the review published without our responses, but the Director, BNHS has circulated this review, calling it a "paper" and "interesting and scientific". Since the language used in the review by its authors Divyabhanusinh and Ranjitsinh is in our opinion rather unbecoming, and judgemental, and questions the very premise of the book and the objectives of the authors in following this premise, we would like to respond. There are also serious errors and misinterpretations by the reviewers in what has been published and circulated as an "interesting and scientific paper" even though it is clearly a book review. We hope our responses to this book review will be published in the next issue of *JBNHS*.

1. On page 3 of this review, the authors ask the question – Why is the book silent on the evolution and arrival of the tiger in India? My answer is very simple. The book explores what is called recent history, and therefore had never intended to get into the evolutionary history of either lion or tiger in India. This fact should be clear to anyone reading the second author Romila Thapar's section. It is also clearly stated by me on page 14 of EXOTIC ALIENS: THE LION AND THE CHEETAH IN INDIA where I ask the question " Is there an evolutionary or genetic basis to my thesis that goes beyond the historical record?" The book is silent on this issue because it was never our intention to examine that aspect.

2. From the last paragraph on page 4 of this review to the second para on page 6, the authors make a persistent effort to state that many of my statements are based on "wishful

thinking" and are not supported by evidence. They are absolutely correct. If I had evidence of large bulk imports of both lion and cheetah in the Mughal period then not only would scores of history books have to be rewritten but we would not even be having this discourse! I have stated very clearly on page 12, last para and page 20, last para that the "premise" I suggest should at least "stir debate" and "provoke research". My part of the book is speculative but based on a massive amount of information that points to the premise that I believe in.

3. The authors of the review (pp. 4–6) therefore need to see the information provided on page 21 of EXOTIC ALIENS, where a miniature painting of the 16th century reveals two Jesuit priests laden with gifts for a Mughal prince including two cheetahs, which clearly establishes that the cheetah was gifted as tributes to the kings! How many were gifted is a question that will be answered when other scholars unearth records that are hugely difficult to find.

4. Furthermore the authors of the review (pp. 4–6) should look at the successes of hand reared cubs in Ranthambhore in the last 12 years and the introduction of a hand reared cub from Kanha into the wilds of Panna. In my opinion, the time and expertise to conduct experiments in the private hunting grounds of the royals in recent history was not only greater than today, but was not governed by any laws whatsoever, so anything and everything was possible.

5. As far as African lions are concerned, it was not just the Maharaja of Gwalior trying to introduce them in the 20th century but also the King of Nepal (see page 179 of EXOTIC ALIENS). In 1938, on the Viceroy's shoot in Chitwan, Nepal there is a fascinating quote "Many reports had been coming from the villages of damage and destruction to their herds of cattle by two new and ferocious animals, which from the descriptions given, were clearly the two African lions that had been released in the valley a month before. His Highness therefore decided to kill them, or they might turn into man-eaters in the future." (Page 115, BIG GAME SHOOTING IN NEPAL by E.A. Smythies, 1942, Thacker Spink & Co., Calcutta). The two lions were killed and I believe many Royals followed this practice throughout history. Lions were introduced before a ceremonial shoot and then killed, and as more people dig out records it is likely that startling information will be revealed. In fact this was the endeavour of the book and I hope it provokes research into records that are closely guarded. For the moment, the authors Divyabhanusinh and Ranjitsinh should correct their statement on page 6 of their review that "The only record that exists of imported animals being released in the wild in India...". The African lions released in Gwalior's forests were not the only record. By the way, I understand that there were many cases of imported Red Deer being introduced in India, but this will be a subject of another paper!

6. On page 11 of the review, the reviewers Divyabhanusinh and Ranjitsinh cast aspersions on the terminologies I use. I leave it to the readers to decide what their experiences of the Gir lion have been and I have given enough narratives of its tameness on pages 173–177 of EXOTIC ALIENS. Early narratives are full of what appears to be "the strange nature of the Gir lion". Millions love dogs and mongrels across the world. My use of these words is to emphasize their domesticated nature from the time the narratives about them started, and I will elaborate on this, since unlike tigers in Ranthambhore and what changed them (page 11, second paragraph of the review), the lion in history (unlike the tiger) is described by some early travellers in its true state. Francois Bernier provides one of the first descriptions of how lions were hunted in the private hunting grounds of the Mughal emperors, dating to the period between 1656 and 1668. "As a preliminary step, an ass is tied near the spot where the gamekeepers have ascertained the lion retires. The wretched animal is soon devoured, and after so ample a meal the lion never seeks for other prey, but without molesting either oxen, sheep or shepherds, goes in quest of water, and after quenching his thirst, returns to his former place of retirement". For several days he is fed asses and when they know that the king is coming they start to tie an ass "down whose throat a large quantity of opium has been forced. This last meal is of course intended to produce a soporific effect upon the lion". (TRAVELS IN THE MOGUL EMPIRE AD 1656–1668 Francois Bernier, an improved edition by Archibald Constable, first published 1891, page 378.) He then goes on to describe how this dazed, opium sodden lion is surrounded by huge nets which are drawn closer and closer. The lion is fully surrounded and then the king appears on an elephant and fires at the lion through the net, etc! Bernier's descriptions are very valuable as unlike the chroniclers of those times there is no bias. The lion is shown as doped and shot without any risk and the process totally stage managed. The chroniclers would narrate the same encounter describing "the ferocious lion" and the story of "bravery and courage" of the great emperor in its dispatch. They were like public relations managers for the kings. This was written for the public in order that they believe in the power of the king over the king of the jungle. I leave it to Divyabhanusinh and Ranjitsinh to decide which version they want to believe. They seem to have great faith in the descriptions associated with the chroniclers! I do not. The tameness associated with the lion in India goes back into history. That is not so with the tiger. Just the first hand description by Bernier should cast doubts on the natural presence of lions in India! Surely anyone with common sense will ask the question – Was this a wild lion or one introduced in an enclosure for the hunt?

7. On page 12, the reviewers contest my estimates of Blackbuck in India. This has to be at best speculative. And while speculating about what they consider that the thousands of lions and cheetahs ate, they should not forget the tens of thousands of wolves and hyenas, etc.

8. On page 12, the authors of the *JBNHS* review state that they have seen prides of 26 lions in Gir. I do not doubt that, as I have seen a pride of 18 there. If the authors had read our book carefully they would have noted that my interest in prides and their numbers concerned pre-1890 observations! So this comment has nothing to do with our book.

9. On page 12, the reviewers discuss the issue of lions crossing rivers. I have been fortunate to watch lions in Africa including the Okavango for more than six months and still am convinced that the lion could not have crossed the Indus. But again all this is my opinion and the speculation by all of us (including the reviewers) is without any scientific evidence!

10. In the last paragraph, page 12 and the first paragraph, page 13, the authors claim that my conjectures on what the Nawab of Junagadh did cannot be accepted as fact. I have never asked anyone to accept it as fact. It is however what all the information collected points to and is therefore a credible conjecture. The chroniclers of the Mughals never discussed the fact of opium sodden lions being killed by kings! Should anyone investigating lion hunting believe solely in the chroniclers' "facts"? The narratives of the past all point to a high degree of domestication of the lion in India, especially after 1890 and in Junagadh. I have no reason to doubt this even if the records of the Nawab of Junagadh state it differently. Anyone who studies these issues must keep in mind the bias of the chroniclers.

11. In the second paragraph, page 13, the reviewers talk of Jahangir's lion hunts. I have read *Tuzuk-i-Jahangiri* and I am not impressed because the chroniclers' accounts are questionable. As far as I am concerned, the reality of the lion hunt is how Francois Bernier described it between 1656 and 1668, as stated in point 6 of this response. The authors further mention the Anup Rai incident of 1610. This has been dealt with in detail by Yusuf Ansari and shows how easily the chroniclers interchanged lion for tiger and vice versa (See text and pictures on pp. 87, 88, and 96, 97, 98. Divyabhanusinh and Ranjitsinh state that "Jahangir goes on to record that in a span of 39 years he had shot 86 lions." Archibald Constable is very clear in 1891 in his improved edition of TRAVELS IN THE MOGUL EMPIRE by Francois Bernier (page 379) that this record is of 86 tigers and not lions. I am more inclined to believe him. There are several scholars who believe that it was tigers that were mainly shot, though much confusion was caused by the chroniclers on this issue of lions and tigers and I can understand the confusion of the authors of this review. But it is clear that such records were not based on fact and had different interpretations by different people. Lions were also much more precious than tigers and this fact is abundantly clear in early hunting narratives referred to in the book.

12. On page 13, paragraph 4, the reviewers discuss the words *Shir* and *Babr* and the confusion that results from this. Yusuf Ansari has dealt with this issue in detail from pages 95–99.

13. On page 13 the reviewers discount all the amazing information that Giovanni Francesco Gemeli Careri, the Italian traveller provides and instead of enquiring into the reasons for hand to hand combat with lions, or how many lions entered Goa from Africa, the authors choose to ignore and dismiss some fascinating nuggets of information from the 17th century. I believe that any historical enquiry requires an open mind in order to pursue information. How many lions arrived from Africa on India's coastline? Subsequent to the publication of the book, I have found records of the 15th century where the Chinese used Calicut as a transit point where they even landed giraffes and lions! The Chinese returned with "sundry unusual commodities, as well as ostriches, lions, and yet another giraffe; such animals were easily transported across the Red Sea from Ethiopia". Could any of these lions have been destined for India and not just in transit to China? We know giraffes were found in the stone sculpture of the Sun Temple in Konark.

14. On page 14, the reviewers state that my captions of lions in a fenced area could be an attempt to "deliberately mislead the gullible". If Divyabhanusinh and Ranjitsinh believe that the painting on page 10 [of the review] with a foreground and background of what appears to be a wooden fence is actually stylized trees, then that is their choice. What about the paintings on pages 122 and 129 [EXOTIC ALIENS]? There are scores of miniature paintings of lion hunts in India during the Mughal period where lions are killed in enclosures and the authors of this review need to examine them in much greater detail. The entire concept of the royal hunt in Mughal India was stage managed to perfection and there are endless visuals depicting this both in EXOTIC ALIENS and in scores of other Mughal paintings.

15. On page 15, the reviewers claim that some of my statements are untrue, e.g., The Maharaja of Bikaner shot 3,300 sandgrouse in one shoot. This shoot is credited to him even though it is obvious that other members participated. I am not suggesting that the person singly killed 3,300 sandgrouse himself! In any case, this example is illustrated to reveal the extent to which the royals stage-managed shoots. In a way, they were massacres that took place in the guise of sport and till the ban on hunting was enforced in 1970 this

royal tradition continued. The killing was done to acquire records and compete with others. The same is true about paintings of African animals that are found in palaces across India – and not only paintings in places like Dungarpur but stuffed animals from Africa are also found in many palaces. Again the context of this is to reveal the connection that existed between the continents and no one can deny either of the above points. So these comments of the reviewers are unnecessary.

16. On the second para of page 15, the reviewers discuss the use of cheetahs. It is not my concern whether Wankaner had or did not have cheetahs since I am quoting from V.D. Sharma and K. Sankhala. I am given to understand that Kutch and Jamnagar had coursing cheetahs in the 19th century, as did endless other princely states. Is there any denying that scores of states used hunting cheetahs and that it was an all prevalent fashion at that time? Would the reviewers consider this to be false or true? That is the question.

17. On page 15, it is Archibald Constable (1891), who when discussing Bernier's descriptions of lions and lion hunting states categorically that "Except in Kathiawar lions are very rarely met with in any part of India now."

18. On page 15, the reviewers suggest that one of my critical quotes from ORIENTAL FIELD SPORTS by Thomas Williamson may not be true or could be an effort to mislead. It shocks me that these two wildlife conservationists have not read this book based on hunting in India in the late 18th century. It would reveal to them what people who traversed India thought about the presence of lions in that time. The quote states "As to lions there are none in Hindoostan... the only one ever seen in that country was that sent from Ghod in 1781, as a present to Mr. Hastings, then Governor General of India. It was considered as a unique animal and has been brought from the north of Persia, where it's said to abound." It is surprising that the authors of the review have missed this vital fact. Do they believe that Williamson's statement of the state of affairs is misleading or false? Not only is he categoric that there are no lions in Hindoostan but goes on to say that it was considered a unique animal and the only one imported in 1781 was from the north of Persia. He covers not just their absence but also their import and this book was one of the first epics to cover hunting across India in a span of 20 years during the last part of the 18th century. And this at a moment of time in the 18th century when the decimation of lions by the British as many would like to believe had not even started! So did the British hunt lions when they were none to hunt? How could they be responsible for the near absence of lions in the 19th century? Do the reviewers consider Williamson a liar? Are they not at least suspicious that lions may have been absent? I am not given to misleading people and any genuine errors in my book will be corrected in the new edition and more information added to my hypothesis. At the same time that Williamson wrote this, Thomas Pennant referred to the debate that raged in India about lions "Here was a royal menagerie, and the breed had propagated from the beasts that had escaped." Pennant was a very well-known naturalist of the 18th century. If Pennant, with others in the 18th century, could reflect suspicions of the origins of wild lions and whether they were escapees from a royal menagerie, surely Divyabhanusinh and Ranjitsinh can at least be suspicious 225 years later. After all, there has to be in all of us a sense of historical enquiry which we pursue without bias, and no one who claims to be a student of history could ignore or not read what Williamson said. My hypothesis was not a figment of my imagination. The very basis of it was being discussed in the 18th century! I will spell out the quote for the reviewers. This statement by Williamson is made in a chapter entitled 'Jackals Rescuing a Hunted Brother' and is on page 116, paragraph 1 of the 1984 edition edited by Antony Atha Publishers Ltd, of which 350 copies were printed. I have in my possession copy 224. The book is a reprint of ORIENTAL FIELD SPORTS: "being a complete, detailed, and accurate description of the wild sports of the East and exhibiting in a novel and interesting manner the natural history of the elephant, the rhinoceros, the tiger, the leopard, the bear, the deer, the buffalo, the wolf, the wild hog, the jackall, the wild dog, the civet, and other undomesticated animals...". It goes on to say on the title page "original, authentic, and curious anecdotes" with a "FAITHFUL REPRESENTATION OF THAT PICTURESQUE COUNTRY" by Williamson who in the 18th century spent "upwards of 20 years" in India. Please note that the lion is not mentioned in the list of animals on the title page, and is relegated to oblivion in this narrative. At least Divyabhanusinh and Ranjitsinh should ask the question – Why did Williamson say what he did on lions? This book is based on Williamson's first hand information of India's wild animals in the last three decades of the 18th century. This is when if there were any numbers of wild lions in India they would have figured in his narrative. Why were lions not a part of his descriptions? Why do they not figure? The only answer I have is that they did not exist and no one in the 18th century talked of them! Can you just arbitrarily dismiss vital clues and information like the above that come from the past? Was Williamson a liar and falsifying information on India's wildlife? Anyone with a sense of enquiry into the natural history of animals would be very suspicious of the presence of lions in India after reading this book. I also have the 1819 edition of the book in which this quote appears on paragraph 2, page 130, volume 1. I hope that the authors of this 'scientific paper', as it has been portrayed, will find time

to read the vital para and I hope it triggers in them at least a suspicion regarding the absence of the lion in India, irrespective of Sir Charles D'Oyly's paintings of lion hunts, for which we have no evidence whether they took place in an enclosure or elsewhere (paragraph 2, page 16 of the review).

19. A premise of the book is that such lion hunts as took place were staged and when they were not, they surprised the hunters who were expecting to kill tigers and not lions. The appearance of the lion could shock locals and even the hunter, who had not seen it before and therefore people like James Forbes in 1781 believed that they existed on the borders of Persia. Paragraph 3, page 16 of the review refer to pages 136–138 of EXOTIC ALIENS. The authors of the review suggest that my statements are contrary. They are not.

20. In paragraph 6 of page 16, the reviewers maintain records of lions shot in Delhi and Haryana during the mutiny. THE BOOK OF THE TIGER, with a Chapter on The Lion in India by R.G. Burton, 1933, makes fascinating reading where he states on pages 273 and 274 that "The *Bengal Sporting Magazine* for 1833 contains a good account of a lion hunt in Harriana...". The lion hunt is then described. Burton goes on to state "This hunt must have taken place before 1830 for in the same magazine in 1831 Major Brown had written that the lion was 'once very numerous in Harriana but there is not one to be found now; the whole of the most favoured tract for them was travelled last year by a gentleman who did not hear of one'." Obviously there was much confusion about the lion's presence and Burton goes to the extent of discounting the date of the hunt since the area was recorded as having no lions in 1930! This would make anyone suspicious and as far as I can see these hunts must have been preplanned and staged, otherwise all these contradictions could not have taken place. Burton goes on to state that 'The naturalist Blyth, writing in *The India Sporting Review* in 1856 says that a lion was killed in Shekawat in 1834. A year later, he remarks that "It is curious that not even a tradition remains of the former existence of that grand and most prominently conspicuous animal in the Harriana territory. The lapse of centuries will sufficiently account for all remembrances of the Rhinoceros having long ceased on the banks of the Indus, where the Mogul Emperor Babar hunted it, and has left so clear a description of the huge beast in his memoirs that there can be no doubt whatever on the subject... It is indeed strange that the King of Beasts should in so very few years have been utterly lost to recollection of the native inhabitants of Harriana." This is the naturalist Blyth writing in 1856, and clearly saying that not a tradition remains of its existence and it is utterly lost to the recollection of the natives. Blyth finds this curious and strange. He had the same seeds of suspicion that I have, and in 1856, just before the so-called records of lions killed from 1857–1858 in Haryana and Delhi by Col. A. Smith. And then, there is Major Brown who states that there is not one lion to be found in Haryana in 1831. In fact those who travel these tracts do not even hear of one. Burton only quoted Blyth and Brown because it was strange and pointed to the lion's absence in areas where it should have flourished. Surely Divyabhanusinh and Ranjitsinh should at least have doubts and suspicions about this issue when so many did in the 18th and 19th centuries! I for one question the records of lions killed by Col. A. Smith.

21. On page 17, the reviewers have published a picture of two lions and make the comment "A pair of mature black maned lion in the Gir, refutes the belief that Indian lion had only a sparse, light coloured mane". They should read what Sir J. Fayrer K.C.S.I., M.D., F.R.S. stated in a paper entitled "Destruction of Life by Wild Animals and Venomous Snakes in India". The paper was read at the Society of Arts on February 1, 1878. Fayrer says of the lion in India "It seems to belong now more to the African than the Asiatic fauna, and probably attains a greater size in Africa. It is of various tints of colour; in India it is of a pale tawny hue, wanting the dark rufous tinge, and has a comparatively scanty mane, which is not so dark in colour than the African variety, and has the median line of hair on the abdomen less developed." He goes on to say "some of the male Indian lions are nearly devoid of mane; the female is always maneless". And further "Its range in India is now very limited, and it would appear to gradually becoming extinct." J. Fayrer was not even able to ascertain records of how many lions were killed by man or how many men were killed by lions and only because of the tiny numbers of lions that existed! For tigers and leopards, the figures are in thousands. For lions, the figures for years on end cannot be ascertained. Surely Divyabhanusinh and Ranjisinh should be asking questions about the lion's presence since so many that ruled both forest and country in the 19th century were talking about maneless lions, a paucity of records, and near extinction! For me the whole matter is questionable and it is information like this that builds the premise of what I believe about lions and cheetahs in EXOTIC ALIENS. After all, Sir J. Fayrer could not have been misleading his reading public on the facts of those times!

22. On page 17, the reviewers speculate on the number of lions left in Gir at the end of the century. I will not join this speculation. I have quoted in EXOTIC ALIENS (pages 155–156) an official record of the British Government from a book entitled THE INDIAN EMPIRE, ITS PEOPLE, HISTORY, PRODUCTS, by Sir William Wilson Hunter, which states clearly "In 1893 when the Durbar became alarmed at the extinction of lions, a rough census was taken... there are now estimated to be only 20 lions remaining in Gir of which 8 are cubs." I don't think

anyone can be more specific. In 1869, Hunter was responsible for a statistical survey of India and its dominions which were later reduced and formed the volumes of *The Imperial Gazetteer of India*. In the present volume Hunter distilled the essence of all his work on India, and in an earlier edition of THE INDIAN EMPIRE (1886) he states "The Lion is now confined to Gir, or rocky hill-desert and forest of Kathiawar. A peculiar variety is there found marked by the almost total absence of a mane; but whether this variety deserves to be classed as a distinct species, naturalist have not yet determined. The lion has now almost entirely disappeared; and the official Gazetteer of Kathiawar states that there are [1884] probably not more than ten or a dozen lions and lionesses left in the whole Gir forest tract." (page 652). I cannot doubt Hunter. Can there be a more credible person to listen to? Do Divyabhanusinh and Ranjitsinh think that this statistician is misleading his readers or falsifying facts? Would they like to correct him? He has called the lion "peculiar" and "maneless"!

23. On page 19, paragraph 4, the reviewers again have got their facts wrong. O'Brien's statement is very much in the book on page 18 of EXOTIC ALIENS. In fact, in paragraph 3 of the said page, Professor Romila Thapar comments on this fact!

24. ADDITIONAL points (a) Divyabhanusinh and Ranjitsinh seem convinced that lions were plenty and roamed northern India and this irrespective of what others in those times felt. Let us look at Francois Bernier's first hand description of a lion that escaped the enclosure in which he was being hunted. Firstly the fact that "during the last hunt, that the enraged animal leaped over the net, rushed upon a trooper whose horse he killed and then effected his escape for a time". If there were plenty of lions why were they escaping and to where? The word escape in a hunt can only mean that there were so few that each one was looked after! In this firsthand description, the lion is hunted within a netted enclosure and there are no "stylized trees" as backdrops! "Being pursued by the huntsmen he was at length found and again enclosed in nets." He goes on to add "The whole army was on that occasion subjected to great inconveniences and thrown into a considerable degree of confusion. We remained three or four days patrolling in a country intersected with torrents from the mountains, and covered with underwood, and long grass that nearly concealed the camels." Can you imagine thousands of people chasing a single lion over a few days and if lions were free ranging and plentiful could this ever happen? Why was the army going out to catch the escapee and net it again when hundreds of other lions were supposed to roam in the area? Was it for the next hunt? Was it to return it to the royal menagerie? Does it not reveal how precious each lion was and how few they were? Bernier believed that any escaped lion was a signal of a bad omen but his entire description on pages 378 and 379 can only point to the very few lions that existed in the 1660s! The reviewers need to ask themselves whether Bernier was misleading the public, lying, or falsifying what he saw with his very own eyes or... [TRAVELS IN THE MOGUL EMPIRE by Francois Bernier.] As far as escaped coursing cheetahs are concerned, it is clear that great care was taken by the handlers to prevent their escape and many must have escaped. See page 214 of EXOTIC ALIENS. The authors of the review mention cheetah catchers and their role. I have clearly shown on page 194 a painting of cheetah catching in a fenced enclosure and this clearly is not of 'stylized trees'! They were therefore caught regularly when they managed to escape in these enormous hunting grounds after a hunt. To me this is plain and simple common sense.

(b) If the reviewers had glanced at the fascinating paper "A Lion's Share of Attention: Archaeozoology and the Historical Record" by L. Bartosiewicz (2009, Institute of Archaeological Sciences, Budapest, Hungary) where the author states "Craniological traits of the now extinct North African Barbary Lion (*Panthera leo leo* Linnaeus) and Asiatic Lions (*Panthera leo persica* Meyer, 1826) are very similar. There must have been a contiguous population inhabiting North Africa and Asia." He then goes on to say "It is possible, that the lion populations of Asia were not contiguous in recent historical times, since no lions were reported either from eastern Iran or Afghanistan". I ask the question that could the North African lion have been imported into India? Would such imports explain the near absence of them and the lack of numbers in their natural state? It might explain why Afghanistan had none.

Let's see what Bartosiewicz says about imports. He states "Stocks of Barbary Lion, the largest of all subspecies, had served as a steady supply to Europe throughout Antiquity: for example Sulla staged 100 "maned" lions in Rome in the 2nd century BC, a gift of King Bocchus of Mauretania. It was certainly from Africa that Claudian believed that Stilicho would obtain the "superb lions" (*eximii leones*) for display at his consular games." He goes on to say "In a number of AD 3rd–4th century mosaics, mostly from North Africa, great hunting parties are depicted, with animals being captured, packed, and shipped to various destinations so that they could be put on stage." Is it so unbelievable to consider that one of the destinations was also India where local rulers could boast on a stage about their "royal" acquisitions? Throughout EXOTIC ALIENS, both in text and visual, there is enough information to suggest that from the 16th to 20th century, lions were kept in royal menageries for use in the royal court and for possible ceremonial hunts. Menageries were holding and breeding stations for animals like lions and surely it is possible that small numbers of lions were imported from time to time to replenish stocks. Should we not be open to this? Is it so unbelievable when the trafficking in live lions was all pervasive across the world? I believe in this premise. It only makes for common sense!

Bartosiewicz also talks of supply from the reedy marshlands around the Tigris and Euphrates "The area had a long tradition of exporting lions. Those captured in Northern Mesopotamia were sent to Constantinople (mid 4th century CE) especially for the games organized by the emperor". Why is it so difficult to believe that some lions entered India because of the same reasons? And even more fascinating is the hijacking of lions in transit! Bartosiewicz states "Gaius Cassius (?85 BCE–42 BCE) quaestor of Syria ordered the shipment of live lions (presumably of local, Syrian origins) to Italy but the transport was hijacked at the ancient city of Megara in Attica (northern section of the Isthmus of Corinth) on the way to Italy." Live lions were moving all over the world and anything was possible! Bartosiewicz goes on to state "Following their extinction in Antiquity, therefore, lions would have been very costly beasts in most places and the expense members of the elite were willing to go through just to put them on display illustrates the hypothetical kudos attached to these animals".

He goes on to discuss the confusion such imports can create "Finally, in light of the copious historical record, one must also reckon with encountering the skeletons of imported, live lions during the later periods of Antiquity and beyond. This is what makes the latest known lion finds identified at Hellenistic colonies in the studied regions so difficult to interpret. It is not really possible to tell, whether later Iron Age finds are the last survivors of the East European population, or the first imports by new settlers." Frankly as far as India is concerned such research should prove fascinating! That imports of lions took place in recent history I have no doubt. I hope that from all this information serious observers at least approach this issue with an open mind. Bartosiewicz goes on to state "To date, the medieval lion skulls from the Tower provide the most unambiguous osteological evidence for historic trafficking in lions." All the information I have collected points to the trafficking of live lions in India's recent history and I hope further investigation will add new light to this premise.

25. The unsavoury remarks on page 20 of the review on the content of the book and the fact that it was created as part of a one-upmanship in the interest of the tiger in order to "buttress the image of one iconic species" does not even deserve a reply as it is so ridiculous. I am the first one to admit that I am not an academic or that this book EXOTIC ALIENS was not put together as a scholarly work (see first para on page 228 of EXOTIC ALIENS). I am also clear that if my premise is proved wrong I am happy to be corrected (page 20, last paragraph EXOTIC ALIENS). I hope that such critiques which skip over the facts and are without any sense of curiosity, enquiry, or even suspicion of the past history of the lion and cheetah in India, are not the basis of further research and debate. May I suggest to Divyabhanusinh and Ranjitsinh that they explore the narratives of the past in much greater detail than they have done, because staring them in the face are all the questions about lions that have been raised by Linschoten, Careri, Bernier, Williamson, Pennant, Major Brown, Blyth, and many others. Could all of them have been misleading the public? Yes, it is correct that we have no evidence of bulk imports of lions and cheetahs. But we never claimed to have! If we did then the issue would be a closed chapter. Our hope is that the future unravels some more information from both the sense of curiosity in others and an openness on these issues, unlike what this so called critique claims it is doing. I know that over hundreds of years some of these people mentioned above kept open minds in order to question the presence of lions in India. If Divyabhanusinh and Ranjitsinh did the same, they would agree that EXOTIC ALIENS may be seen as a starting point drawing attention to an information base for further research and investigation into the near absence of the lion and cheetah in India's recent natural history. That, in fact, was the very simple objective of all three authors. We hope this book will be a catalyst in that endeavour.

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EXOTIC ALIENS LION AND CHEETAH IN INDIA: A REJOINDER TO AUTHORS' RESPONSE TO OUR REVIEW

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In response to our critique appearing in the *Journal of the Bombay Natural History Society* 110(1): 3–21, Jan–Apr 2013, the authors of EXOTIC ALIENS: THE LION AND THE CHEETAH IN INDIA have come forth with a response to be published in the May–August 2013 issue. We have been asked to give our rejoinder to the same.

At the outset, we do not wish to enter into a sparring debate with the authors, especially since they have not brought forth any additional proof, nor given any incontrovertible evidence to support their contention that lions and cheetahs were introduced into India by humans. However, since they have given a lengthy rebuttal to our critique, it would be appropriate to briefly discuss some of the salient issues raised.

Firstly, ours is not a review of the book in question, as its authors contend, but a critique of the theory of lions and cheetahs being introduced in India by man, which is the very *raison d'être* of the book and indeed, its main purport. We will, therefore, mainly confine our rejoinder to this central issue, rather than delve into semantics revolving around conjectures and the veracity or the lack of it, of the various authors quoted.

We have cited specific fossil evidence of lion in Sri Lanka and in the Bankura district of West Bengal (page 18), and of archaeological finds of bones of the cheetah of the Mature Harappan Period (*c*. 3000–2500 BCE), found in Kanmer, Gujarat, and also in Uttar Pradesh of a later date (page 7). All the three authors in their response have chosen to simply avoid any mention of this incontrovertible proof. Is this how evidence is to be treated, in either history or science?

In response to our mention of lion and cheetah being painted in rock art during the Neolithic/Chalcolithic period (2500–3000 BCE), Professor Romila Thapar states that the dating method of rock art remain controversial. Not entirely. We would draw attention to the work done to analyze samples of rock art from the Bhopal region, to determine their mineralogical and chemical composition, 14C dating, micro-erosion analysis, and optically stimulated luminescence dating. Prof. Thapar further claims that lions were brought into India just before the Mauryan period. Under no circumstances are these rock paintings of a period as late as that. Of the ostensible cheetah import, the authors do not venture to offer a date. Are we to presume that cheetahs were imported in the Sultanate/Mughal period when they came into "fashion" and that these rock paintings of cheetah therefore, belong to the medieval period of Indian history?

Prof. Thapar describes rock paintings of cheetah and leopard depicted in figures 1 and 2 of our critique, as almost bovine. Of course, the paintings are slightly stylized. But whether the stilt-like legs of the cheetah and the paws and tails depicted in both paintings are characteristics of bovids or of felids, we would let the viewers decide. Prof. Thapar goes on to say that "There is a world of difference between the so-called cheetah and the recognizable leopard in the reproductions." That is precisely why the two paintings have been reproduced in our critique – to show the world of difference between the two spotted cats, between the cheetah and the leopard depicted in the paintings.

We had mentioned in our critique that whilst the lion and cheetah are labelled as exotic aliens in the book, Prof. Thapar mentions India as the indigenous habitat of the tiger. What does this imply – that the tiger is indigenous to India and therefore has evolved here? Our query is deftly circumvented by her statement "Am I maintaining that India was where they (tigers) evolved?" Since the entire book EXOTIC ALIENS is dedicated to prove the exotic origin of the lion and cheetah in India and the tiger is deemed to be indigenous, the readers of the book as much as ourselves, would be eager to know whether the authors of the book believe the "indigenous" tiger to have evolved indigenously in India, or to have come from outside of India and hence an exotic alien like the lion and cheetah. This question remains evaded and unanswered in the response of the three authors.

The authors, neither in the book EXOTIC ALIENS nor in their rejoinder, mention as to how the cheetah came to Iran. It must, therefore, be presumed that they accept that the animal arrived in Iran on its own and where it continues to exist even today. Indeed, the cheetah survived in Baluchistan in Pakistan, at least till the last decade of the last century. If the cheetah could still survive in the Saharan Desert and cross all the way from southern Africa where it evolved, right through the length of Africa and the deserts of the Middle East and Iran, could it not have travelled a few more miles from arid Baluchistan to Sindh and the rest of India? Cheetah were reported in Turbat (S.E. Baluchistan) in 1968, in Chagai (N.E. Baluchistan) in 1997 and in Ormara right on the Mekran coast of Baluchistan, some distance west of Karachi, also in 1997 (Divyabhanusinh 2006, page 197). Could the cheetah not have emulated and followed the dispersal routes of the spotted hyena, the gazelle, the lugubrious little pangolin, and even the tiny ratel (honey badger) and the even smaller hares? If these species could have crossed the deserts and the Indus, could not the lion and the cheetah? Or did these smaller and more water-averse species, according to the hypothesis of the authors vis-à-vis the arrival of lions in India, all arrive in India transported by man, from Balkh, Badakhshan, Afghanistan or elsewhere? Or were they also brought in on sea-faring vessels, as the cheetah has supposed to have come?

Or is it expostulated that the gazelles, pangolins, ratel, and the rest went through Afghanistan and then crossed the Indus upstream? If the waters of the lower Indus, according to the authors, posed an insurmountable barrier, would not a crossing upstream in upper Sindh and the Punjab where the Indus flows much deeper and faster, be even more difficult? Yet arrive in India they did, these species. So how? In the past millennia, the Indus flowed much more eastwards than it does now and was broader and shallower. Besides, the climate of the world has been different in the past. Sahara held giraffes even till historical times, as rock carvings in the Niger Sahara and rock paintings in the Libyan Sahara, prove. This implies the existence of tree flora, without which giraffes could not have survived. This biota would have greatly facilitated the lion and the cheetah to live in the Sahara and to cross over into North Africa. Would not there have been more vegetation then also in the Middle East and in Baluchistan? On their long, long journey from southern Africa, did the lion and cheetah not have to cross large rivers other than the Indus? The authors of the book are perhaps aware of these facts. But then the acceptance of them, and of the natural passage of the lion and cheetah from Baluchistan into Sindh and across the Indus into India like the gazelle, pangolin, ratel, and the rest, would make the book EXOTIC ALIENS redundant.

The book EXOTIC ALIENS does not give a single citation of an import before the 20th century, or release or escape from captivity of imported lion or cheetah, at any point of time. Neither does the lengthy response from the authors of the book. Indeed, they have admitted the lack of evidence in this regard. At one point Valmik Thapar admits that his surmise is based upon "a credible conjecture". Are the readers to accept a theory based upon "credible conjectures" without the support of valid evidence and in contradiction of incontrovertible evidence to the contrary? If the absence of some species in Harappan seals or in some art forms, or the lack of evidence of lions having occupied the Mekran coast in Baluchistan in the past, is to be regarded as proof of the absence of those species on Indian soil, should not by the same token the absence of the mention of any import of lion and cheetah into India, in any account, contemporary or otherwise, even medieval or modern prior to the 20th century, be accepted as proof that no such import was carried out? It is surprising that a historian of the repute of Prof. Thapar should choose to come to conclusions without the support of historical evidence.

Prof. Thapar and Valmik Thapar state that it was never their intention to refer to the cheetah and the lion in derogatory terms, the latter going on to say that "Millions love dogs and mongrels across the world". Are we then to assume that epithets such as dogs, mongrels, "khichdi", imposters, etc., are terms of endearment, or are apt descriptions of lion, cheetah, or for that matter of any wild animal, in writings pertaining to history, science, or literature?

The authors repeatedly mention the gift of cheetahs to Indian nobility. But there is no evidence of import of cheetahs for gift. Valmik Thapar cites page 21 of the book on which there is a reproduction of a painting of Jesuit priests "presenting" cheetahs to Jahangir. The cheetahs in the picture are being handled by Mughal retainers and could have belonged to Emperor Jahangir himself, whose love for the animal is well-known and the depiction of cheetahs at the Mughal court is a common subject in numerous Mughal paintings. Even if it be accepted that they were being brought by the priests to court for presentation, could they not have been acquired in India where the Mughals themselves and others were capturing and taming cheetah in large numbers? Where is the evidence of cheetah import? Thomas Williamson's statement that there are no lions in "Hindoostan" in the last decades of the 18th century, is regarded by Valmik Thapar as the final verdict on the absence of the animal in India. Did Williamson travel to Gujarat or to the Gwalior region of Madhya Pradesh, in both of which areas lions were still to be widely found in this very period, the proof of which has been given in a book written by Divyabhanusinh? Williamson's entire work is a vignette of his shikar experiences in Bengal only, which was not the habitat of the lion or of the cheetah. Valmik Thapar also chooses to ignore Sir Charles D'Oyley's work, which is contemporaneous and has in it lions, cheetahs, tigers, and others, all of which are prominently portrayed in the work.

Mr. Valmik Thapar in his response says that the two of us are correct in saying that many of his statements are not supported by evidence, are based upon wishful thinking and that his desire was to stir a debate and to provoke research. This standpoint is also endorsed by Prof. Yusuf Ansari, who goes on to say that at no point has he drawn definite conclusions and has only laid out "historiographical posers" and wanted to stir a debate, and that from our response he has the satisfaction of knowing that he has succeeded in some measure in this regard. This, indeed, is a very refreshing approach. If the book EXOTIC ALIENS had posed a hypothesis for consideration, it could have given an impetus to research and to elucidation of available evidence, historical and scientific. By that token, the authors should have welcomed our response and accepted the palaeontological and other evidence that we have put forth, or given valid reasons for their non-acceptance.

Instead, the book comes to a definite conclusion on a hypothesis based upon no credible evidence, to support a preconceived notion, and when confronted with incontrovertible proof, the authors, instead of addressing the adduced evidence in an academic spirit, react angrily, indulge in more obfuscations to further confuse the reader, and continue to dogmatically adhere to an untenable surmise and to defend an indefensible theory.

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ERRATA

JBNHS 110(1) Jan-Apr 2013 pp. 3–21: 'Lion and Cheetah in India: A Critique'

Page 4, left column 10th line from top:
For … from where they moved **westwards** into the Indian subcontinent.
Read … from where they moved **eastwards** into the Indian subcontinent.

Page 4, left column 20th line from top:
For… **westward** march from Iran.
Read … **eastward** march from Iran.

Page 5, right column 4th line from top:
For … colonization **westwards** stopped on the borders of Iran, …
Read … colonization **eastwards** stopped on the borders of Iran, …

Journal of the Bombay Natural History Society, 110(2), May-Aug 2013 **108-113**

THE "EXOTIC ALIENS" CONTROVERSY: A VIEW FROM AFAR

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It seems that that the publication of EXOTIC ALIENS: THE LION AND THE CHEETAH IN INDIA by noted historians and chroniclers of natural history Valmik Thapar, Romila Thapar, and Yusuf Ansari (henceforth referred to collectively as Thapars and Ansari) last year has caused a bit of a stir, at least in the conservation community in India. Thapars and Ansari's (2013) principal thesis reasons that there is now compelling historical evidence to support the proposition that both the wild lions and the now extinct cheetahs of India derive from human assisted importation as far back as 2,000 to 3,000 years ago and subsequent release (or escape). Across time, wildlife naturalists presumed they were native since records of their introductions were scant and the species were there. Today approximately 400 Asiatic Lions survive in the Gir National Park in Gujarat State, while the last wild cheetah record in India can be traced to 1968 (Divyabhanusinh 2006).

Thapars and Ansari have presented a learned, detailed, and scholarly historical review of the amazing art, writings, and science about the occurrence of the lion and cheetah in India over recent years that was for myself delightful and informative to read. They suggest that in contrast to tigers, the paucity of reference to lions and cheetahs in literature and art in historic times, since the printing press was invented, raises the question of whether the two species were imported from Africa by regal potentates as trophies or treasures. They conclude that if that were true, it probably means there were few if any wild populations of the two species in India, and the myth of indigenous ancient Indian origins was propagated by scribes simply restating conventional wisdom in their time.

EXOTIC ALIENS has been read and digested by many wildlife lovers including experts of various perspectives. One view published in the *Journal of the Bombay Natural History Society* by wildlife conservation experts Dr. Divyabhanusinh and Dr. M.K. Ranjitsinh (2013), disputes the conclusions of the book strenuously and takes some offence at what they consider a polemic with little supporting evidence. They refer to important monographs on both species, including ones penned by Divyabhanusinh (2006, 2008), and lay out a detailed rebuttal to the book's evidence (or rather lack thereof) and conclusions. In some spots they impugn motives of the authors' using of pejorative, even inflammatory label- "…exotic aliens, dogs, mongrels, imposters, khichdi, etc.", as a not so veiled strategy to deflect limited conservation resources from cheetahs and lions to the entitled indigenous tigers of India.

Perhaps in some part because either side of the debate has cited my own works including "Tears of the Cheetah" (O'Brien 2003), the editors of the *Journal of the Bombay Natural History Society* have solicited my views, hoping to offer an outside disinterested opinion on the flap. My own background comes from a rich career employing genetic data in wildlife species, including interpreting genomic footprints in modern species' DNA sequences that descend from the silence of prehistory. I admit that I am interested in the question, having studied lions, cheetahs, and tigers with my students and fellows for many years.

Thapars and Ansari write that they believe lions and cheetahs arrived in India for the first time 2,500 to 3,000 years ago, just before or during Alexander's invasion of India at 326 BCE (Thapar *et al.* 2013). Divyabhanusinh and Ranjitsinh (2013) argue that the bulk of the data suggests otherwise that cheetahs and lions were here much earlier and that labeling them as exotic aliens is both inaccurate and misleading. They mention that Thapars and Ansari fail to produce a single citation (aka no evidence) of any cheetah or lion imports before the 20th century, and that Thapars and Ansari actually admit to that. Divyabhanusinh and Ranjitsinh (2013) resurrect the spirit of Carl Sagan's timeless quotation: "*Absence of evidence in not evidence of absence!*" Indeed, they wonder how Thapars and Ansari can conclude that the absence of historical records of cheetahs and lions indicates they were not there, and at the same time ignore the absence of documented evidence for cheetah or lion importation or wild-release before the 20th century.

To resolve such a question boils down to reviewing the substantiation offered for each side. To me, compelling evidence can derive from three general areas: 1) Historical records as those detailed by Thapars and Ansari; 2) Archaeological and palaeontological remains and their dates; and 3) Molecular genetic inference based upon molecular clock calibrated by fossil dates. Each of these aspects is discussed in some detail by the provocateurs, so how can they arrive at such polarized endpoints? The devil is in the details. Every species comes from some place; this is the lesson of evolutionary history. Two precise questions may be stated: when did cheetahs and lions appear in India, and was their origin anthropogenic? Because the relevant data or evidences are somewhat different for lions and cheetahs, I shall discuss each species separately.

Lions: Lions are a member of the family Felidae, genus *Panthera* that includes the great roaring cats (tiger, leopard, snow leopard, and jaguar). The origin of *Panthera* is traced to Asia 5-7 MYBP (million years before the present) according to molecular and palaeontological evidence (Johnson *et al.* 2006; O'Brien and Johnson 2007; Werdelin *et al.* 2009). Lion precursors made it to Africa where the palaeontological record reveals the first lions approximately 2MYA in Olduvai deposits. Approximately 300,000 YBP, lion remains begin to appear in northern and eastern Asia. Shortly thereafter, enabled by lower ocean depths, lion precursors traversed the Bering Strait into North America, where they flourished until the end of the last ice age (10-12,000 YBP).

Thapars and Ansari (2013) detail written studies and art that demonstrate the paucity of reference to wild lions in the face of abundant descriptions of wild tiger encounters in historic times. They also argue that lions cannot swim across the Indus, based on their observation of the swimming lions of Botswana Okavango. Divyabhanusinh (2008) presents an equally detailed and learned account of lion references during these periods as well.

No one disputes that Indian rulers treasured and held lions, and I for one would not be surprised if they had imported African lions on a few or multiple occasions. But does importation and release preclude the existence of relict ancient indigenous populations? Probably not. There occur to me other examples where presumed absent or extinct fauna were rediscovered. Florida panthers, black-footed ferrets, northern elephant seals all were presumed extinct and reappeared. A glaring re-emergence was the African elephant genus *Loxodonta,* which was virtually absent from Africa palaeofauna during most of the Pleistocene, while *Elephas*, the Asian elephant genus, was predominant in palaeontological remains in African savannahs (Maglio 1973; Sanders *et al.* 2010). During the lower Pleistocene, *Elephas* fossils abruptly disappeared from Africa, to be replaced by relict populations of *Loxodonta africana* - savannah and *Loxodonta cyclotis* - forest elephants that survive today (Maglio 1973; Roca *et al.* 2001; Sanders *et al.* 2010).

The fossil record clearly shows lions in Asia during the Pliocene and Pleistocene. Divyabhanusinh and Ranjitsinh (2013) quote several references that describe lion specimens in Sri Lanka, India, and West Bengal during the Pleistocene (~2MYBP) (Deraniyagala 1958; Dutta 1976; Manavendra-Arachchi *et al.* 2005; Sunquist and Sunquist 2002). I should mention that these lion pronouncements in recent archaeology may be dicey, since it is quite difficult to discriminate lion from tiger skulls, skeletons, or teeth morphologically.

Today around 400 wild lions live in the Gir Forest in India and have been studied for genetic, ecological, and taxonomic considerations. Their molecular genetic diversity is dramatically reduced due to extreme population bottleneck or founder effect in their recent history (Driscoll *et al.* 2002; Gilbert *et al.* 1991; O'Brien *et al.* 1987a; Wildt *et al.* 1987) . The two groups cite and acknowledge our genetic-based estimate of the timing of the founder event (i.e., when Gir lion ancestors dropped to very low number) at approximately 2,100 years ago (Driscoll *et al.* 2002). Thapars and Ansari (2013) take this dating as support to their reasoning that the modern Gir lions got there by human provenance around the time Alexander's army invaded India in 326 BCE.

Though at this stage you might believe here there is a stalemate, the last data bits are revealing. A comprehensive analysis of lion subspecies molecular genetic distance led by Agostinho Antunes (Antunes *et al.* 2008) made two interesting points. First, the mass of all lion DNA diversity today in Africa and Asia points to an origin of lion populations at 250,000 years ago (169,000-324,000 YBP) in Africa. Second, there exists an appreciable genetic distance between modern Gir and African lion populations, indicating they have been separate populations (no gene flow between them) for approximately 100,000 years. This means that for 100,000 years the Gir lions have been isolated from African populations completely. This genetic distance approaches the genetic distance between African and Asian leopards (169,000 YBP) and is greater than the genetic distance separating tigers subspecies (approximately 72,000 YBP), which no one suggests were human assisted (Table 1). The simplest explanation would be that the Gir lions' progenitors reached Asia 97,000 years before Alexander, but were out-competed by tigers, relegating the lions to small refugia or states outside

Table 1: Times of separation estimated by molecular genetics*

Species/subspecies/groups	Dates	Citations
Clouded leopard species	1.4 MYA	Buckley Beason *et al.* 2006
Orangutan species	1.1-1.7MYA	Lu *et al.* 1996
Asia vs. Africa lions	100,000 yrs.	Antunes *et al.* 2008
Asia vs. Africa leopard	169,000 yrs.	Uphyrkina *et al.* 2001
5 living tiger subspecies	72,000 yrs.	Luo *et al.* 2004
Asia vs. Africa cheetahs	4500-6500 yrs.	O'Brien *et al.* 2014
Asia vs. Africa people	70,000 yrs.	Forest and Matsumer 2005

* There are multiple additional citations supporting these dates

of India that percolated until historic times. If something like that did not separate Gir lion ancestors from Africa, I have no explanation for the large genetic difference between African and Asian lions living today.

Perhaps also of interest is the written science record that consistently describes the range of the Asiatic lion subspecies across Asia in prehistoric and historic times. Many authors believed and wrote that lions had wide range in Asia from northern Greece across south-west Asia to eastern India (Guggisberg 1963; Joslin 1973; Neff 1983; Nowell and Jackson 1996; Sunquist and Sunquist 2002; CSG-IUCN). I am not sure if this qualifies as written evidence of sightings or encounters, but these experts list explicit archaeological evidence (see caveat above) and clearly believed the historic range was occupied by lions for millennia before Alexander's adventures. Lastly, the prospect of Gir lions being "hybrids or mongrels" would be easily revealed and apparent by genetic inspection if it were so; but it was not. Gir lions are homogeneous, genetically reduced, and a great genetic distance from African cousins.

I should mention that the captive breeding programme of Asiatic lions among world zoos in the 1980s was indeed demonstrated to comprise subspecies hybrids, as two of seven founder lions were shown to be of African origin (O'Brien *et al.* 1987b). This African "imposter" founder lion very likely derived from captive zoo lions, since no African genetic lineage was ever discovered among wild caught Gir lions sampled in recent decades. This captive programme was quickly halted by "pure subspecies" advocates, and that sordid history may have been the source of the Thapars and Ansari's suggestion that Gir-Asian lions may be hybrids. Sorry for that, but it did not impugn the ancestry of wild lions in the Gir forest of Gujarat.

Cheetah: The fossil record is rather clear in demonstrating that the cheetah genus *Acinonyx* developed in North America during the Pliocene, 2–5MYBP (Neff 1983; Johnson *et al.* 2006; O'Brien and Johnson 2007; Werdelin *et al.* 2009). Combined molecular, palaeontological, and geological data imputed that the predecessors of American felid species (puma, cheetah, and jaguarundi) traversed the Beringia [now Bering] Straits from Asia to America in the late Miocene, 5–6.6 MYBP. Cheetah forbears appeared in Asia during the Pleistocene, product of an earlier migration from North America back across Alaska and Siberia to Central Asia, from which they would migrate southward to colonise Africa in the late Pleistocene (Johnson *et al.* 2006; O'Brien and Johnson 2007; Werdelin *et al.* 2009). The cheetah's fossil record includes specimens throughout Asia, plus the continued survival of approximately 100 cheetahs in Iran parsed into seven or more small isolated relict populations (National Conference on Iranian Cheetah 2013; Nowell and Jackson1996). The last free-ranging Indian cheetah died in 1948.

Cheetahs disappeared suddenly in the North American Lower Pleistocene, part of the most extreme species extinction in the 100 million years history of mammals. That cataclysmic event eliminated 75 percent of large mammals from North America, including mastodons, mammoths, giant ground sloth, short-faced bears, saber-toothed tiger, American lions, pumas, and cheetahs (Neff 1983). Modern cheetah species' genetic depletion, debated, validated, and replicated on multiple levels, was the consequence of a severe demographic reduction, a population bottleneck, that occurred over time and space within the past 10-20,000 years (Menotti-Raymond and O'Brien 1993; O'Brien *et al.* 1983,1985, 1987c; O'Brien 2003). We have suggested that the American extinction, combined with the earlier geographic dispersal back to Asia and Africa, likely precipitated demographic and genetic reduction through behaviour reinforcement of large range boundaries, leading to the derivative African cheetahs' remarkable reduction in overall genic diversity.

Thapars and Ansari present a detailed account of the fascination that Indian Mughals, particularly Akbar, enjoyed with captive menageries of cheetahs. Much of Thapars and Ansari's chapter on cheetahs is devoted to direct quotations of recent writings describing cheetah occurrence. Divyabhanusinh (2006) presented a learned account of these historic periods as well. There can be no doubt that cheetahs lived in India in historic times, that they were held in royal compounds, and that they were trained to hunt in game reserves. But were they African imports - imposters or native indigenous species or perhaps both? In this case, the question of evidence comes from two areas. First, archaeological and palaeontological descriptions which suggest ample remains that put cheetahs in Asia throughout the Pleistocene before Alexander's campaign (Guggisberg 1975; Nowell and Jackson 1996; Sunquist and Sundquist 2002; Werdelin *et al.* 2009). Second is the molecular data, also informative but requiring a bit of interpretation, which I shall attempt (Charruau *et al.* 2011; O'Brien *et al.* in press).

With the existence of the Iranian cheetahs, there was a nattering question even before EXOTIC ALIENS was published that wondered, like Thapars and Ansari, whether the Iranian cheetahs were an indigenous Asiatic population or possible derivative of African imports. We knew that African cheetahs were all descended from the putative population bottleneck of the late Pleistocene,10–20,000 YBP. But the Iranian question was tricky because no one knew if the Iranian animals descend from a pre-bottleneck cheetah ancestor or a post-bottleneck cheetah ancestor. If it were pre-bottleneck, i.e., they would show large genetic distances from African populations, similar to leopards, tigers, major human ethnic groups on the order of 100,000 years (Table 1). If post-bottleneck Iranian cheetahs descend from the same population bottleneck, we expect that modern Asian cheetah genetic diversity would be nested within overall African diversity at <10-12000 years. Also if it were the latter, how could we tell whether the Iranian cheetah was a post-bottleneck indigenous Asian cheetah or a post bottleneck import from Africa? One answer came when the genomic data were examined.

We examined mtDNA sequences from 21 African and Iranian-Asia cheetah specimens representing four genes (ATPase, ND5,12s-RNA,16S-RNA; 1498 BP). DNA sequences of these genes showed distinct phylogenetic separation for cheetah specimens from East Africa, South Africa, Somalia, and Iran (O'Brien *et al.* in press). The Iranian cheetahs did show clear divergence, meaning isolation for some time interval; but for how long? The genetic measures indicated that the Iranian cheetah genes were about the same genetic distance from African cheetahs as were isolated African cheetah populations from each other. The African populations and Iranian populations were all rather close, i.e., approximately 4,500 and 6,500 years (Table 1). An independent group (Charruau *et al.* 2011) published a similar study where they report the same patterns, good separation of the Iranian and African populations, but equivalent distance between African populations as for Iranian versus any African population. This equivalence of inter-population genetic distance means that the Iranian cheetah, like African groups, derives from survivors of the 10,000+ years old population bottleneck.

Charruau *et al.* (2011) make a strong argument for the distinctiveness of the Iranian cheetah, e.g., meriting separate subspecies status and unique unit of conservation, etc. Nonetheless, their data are clearly near identical to our findings, albeit with one important wrinkle. Charruau *et al.* (2011) include one museum specimen of a purported "Indian cheetah" from the Natural History Museum in London. That individual very closely aligned with the Iranian cheetah population. If this result is affirmed (and it should be), then it means that the Iranian and Indian cheetah specimens share a common ancestor somewhat more recently than either does with Africa. To me, the simplest explanation here is that Asiatic cheetahs in Iran and India were both founded around the same time modern African cheetahs originated (10–20,000 YBP), but they remained behind in Asia (i.e, Iran, India, and thereabouts) and split apart a few thousand years later, perhaps in historic times. This indicates that the Indian and Iranian cheetahs are indigenous and recently founded before Alexander by the Asian cheetah survivors of the late Pleistocene bottleneck.

Of course I wasn't there at the time, and it is not inconceivable that both Iran and Indian cheetah populations could descend from an African Import, but that import would have evolved some place in Africa undiscovered by the two independent molecular studies (Charruau *et al.* 2011; O'Brien *et al.* in press). By molecular means alone, we cannot exclude prehistoric imports of cheetahs to India (there probably were some), but neither can we reject (I tend to accept) the traditional view that Asian cheetahs, like African cheetah, were founded 10–20,000 years earlier when the survivors of the cheetah Pleistocene bottleneck passed through Asia and into Africa. As for the paucity of sighting in India, this was also true of very elusive cheetahs in Namibia or pumas in North America which are seldom if ever encountered in bushy habitat without a trap or trained dogs to sniff them out.

Conclusions and Implications

The provocative challenge of EXOTIC ALIENS to stimulate a spirited debate and discussion around the prospect of unacknowledged anthropogenic introductions of cheetahs and lions during recent historic times has been accomplished. Many in our field have read and reacted to the ideas and I have had a chance to weigh in here. My own conclusions remain tentative. However, the bulk of the credible evidence would support the indigenous Asian origin for the lions that live today in the Gir Forest. This does not, of course, preclude the possible import, release, or escape of African lions, but in our admittedly limited sample we see no genomic traces of African lion in the Gir lions today.

The cheetah's natural history is a bit less certain, largely because discriminating between an import-release 3,000 years ago and a founder effect 10–12,000 years ago is near impossible with molecular chronometers. That said, since cheetahs clearly originated from a 10–20,000 founder effect in Asia, and Asian cheetahs from India and Iran display a genetic consanguinity, I cannot exclude the possibility that distinctive Asiatic cheetahs descend from the recent founder event for both continents and lingered in Asia while the African cheetahs were radiating across Africa during the recent millennium. This cautious speculation does not preclude any historic importation of African cheetahs, yet as for the lions, so far we see no relict genomic footprints of African heritage in Asian animals tested to date. Finally, although no one can say for certain that Asian cheetahs were present in India 3–10,000 years ago, how important is the answer? We know cheetahs arrived in Asia 3,00,000 years ago and remained until the 10–12,000 YBP bottleneck and then also from 3,000 years ago until 1968. If cheetahs were present 293,000 years in Asia, missing the 7,000 years according to Thapar *et al.* (2003), then they were occupying

Asian habitats for 98% of the last 300,000 years. To me, that should be enough for native indigenous Indian citizenship!

The conservation imperative for lions and cheetahs in India seems a worthy and justifiable cause. Asian lions once roamed across southern Asia in numbers and populations limited by the advantaged tigers. Yet they survived in at least one population that should in my view be restored to other suitable habitats with sufficient prey to increase the hope of sustaining the Asiatic lion for the future. The restoration of cheetahs into Indian reserves selected recently would double the continental range of this fragile and highly adapted species. The close kinship of Asian to African cheetahs speaks volumes, offering irrefutable evidence that there is no credible genetic reason to preclude the use of modern African (Namibian or South African) founders, as these two groups did surely exchange genes very very recently (Table 1) .The squabble among nature conservationists will continue, but action to stabilize and maintain species like the cheetah to their former habitat seems a wonderful goal that should be accomplished very soon, as the genetic and natural history evidences clearly point to the feasibility and urgency of such a cause.

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THE MAMMALS OF SRIHARIKOTA ISLAND, SOUTHERN INDIA, WITH INSIGHTS INTO THEIR STATUS, POPULATION, AND DISTRIBUTION

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Inventory surveys, transect surveys (day), and roadside surveys (night) were carried out from November 2001 to October 2007, to document the mammalian fauna of Sriharikota and assess their population and distribution in the island. The surveys covered four habitat types, namely tropical dry evergreen forest (TDEF), open scrub, eucalyptus, and casuarina plantations.

Twenty-eight species of mammals were recorded; most of which are common or widely distributed in India. The records of the Rusty-spotted Cat *Prionailurus rubiginosus* and Grey Slender Loris *Loris lydekkerianus* in Sriharikota are of conservation interest. The Bonnet Macaque *Macaca radiata* and the nocturnal Small Indian Civet *Viverricula indica* were not recorded in plantations. The encounter rate of the Three-striped Palm Squirrel *Funambulus palmarum* was higher in forests than in plantations (Mann-Whitney U=1067, p<0.001), and within the natural habitat, it was more in TDEF than in open scrub (Mann Whitney U=288.0, p<0.05). The encounter rates of the Golden Jackal *Canis aureus* and Indian Hare *Lepus* (*Indolagus*) *nigricollis* were higher in natural habitat than in plantations (Mann-Whitney U=1390, p<0.01 and U=1536, p<0.05, respectively).

The takeover of the Island by the Indian Space Research Organisation (ISRO) and its high security status has overall been a boon for the wildlife and their habitats. However, the issue of plantations, and expansion plans of the spaceport that will involve loss of forests are threats that call for a long-term conservation plan.

Key words: Sriharikota, mammals, *Loris lydekkerianus*, *Prionailurus rubiginosus*, tropical dry evergreen forest, open scrub, plantations, eucalyptus, casuarina

INTRODUCTION

Sriharikota Island, off the south-eastern coast of India, is important from the biodiversity point of view as it has the last remaining, largest, and best-preserved tract of coastal Tropical Dry Evergreen Forest in India (Meher-Homji 1974; Suryanarayana *et al.* 1989, 1998). The Indian Space Research Organisation (ISRO) took over the Island in 1969 to develop it as India's spaceport, and ISRO also made efforts to protect the forests and its wildlife.

As part of a BNHS-ISRO project to document the biodiversity of Sriharikota Island, we undertook an exercise to document the mammals of the Island (Manakadan and Sivakumar 2004). The objective of the study was to make a checklist and assess the status and distribution of the mammals on the Island. Additionally, we also estimated the encounter rates in different habitat types, to investigate the impact of plantations on the different species. The data obtained was supplemented by information obtained on some of these species during two other studies carried out from November 2004 to May 2008 (David *et al.* 2008; Sivakumar and Manakadan 2008).

STUDY AREA

Sriharikota (13° 71' N; 80° 20' E) is a spindle-shaped island (181 sq. km) situated in Nellore and Tiruvallur districts of Andhra Pradesh and Tamil Nadu respectively (Fig. 1). The island is bordered to the east by the Bay of Bengal and on the north, south, and west by Pulicat Lake. The Island comprises of low ridges of sand, marine and aeolian in origin, rising 4.5–6 m above msl and sloping from west to east. The water table is at a depth of *c.* 2–5 m.

The rainfall is largely from the North-east monsoon (October–December). Some rainfall is also received from the South-west monsoon (June–September). The area is prone to cyclones, usually in the early part of May and October, prior to the onset of the two monsoons. The annual rainfall is *c.* 1,200 mm. December to February is the winter season with temperatures as low as 10° C; March to September is the summer season with temperatures soaring over 40° C. Relative humidity is lowest during May (18%), and maximum during October (99%).

Prior to the takeover of the Island by the Indian Space Research Organisation (ISRO) between 1969 and 1972, there

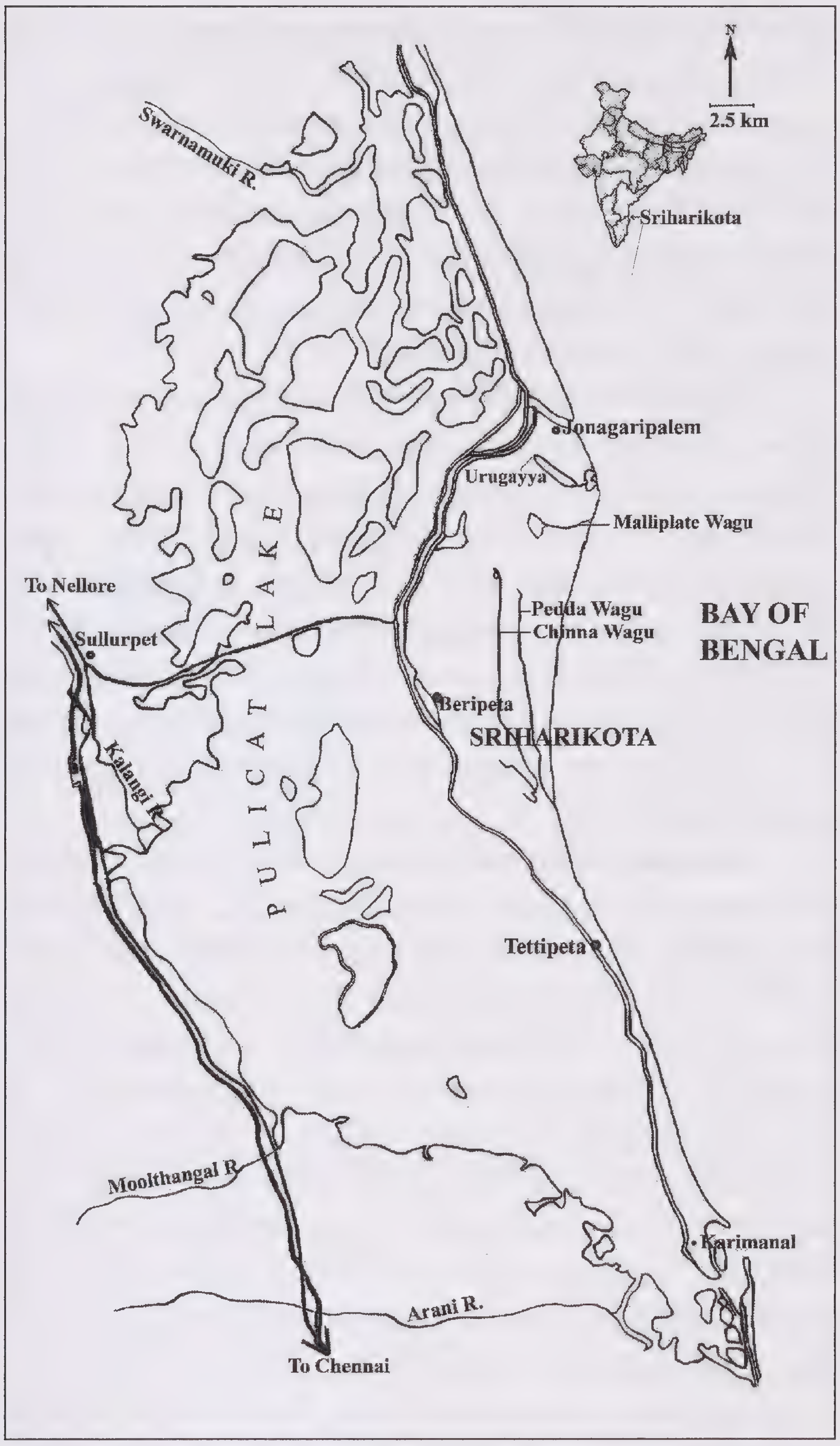

Fig. 1: Sriharikota Island

were around 20 villages in the Island with a total population of around 10,000 individuals. At present, besides the establishments of the Satish Dhawan Space Centre (SDSC-SHAR), there are colonies established by ISRO for the former settlers and tribals of the Island, many of whom are employed by ISRO. Access to and movements on the Island are restricted. The SDSC-SHAR has a Conservation and Landscape Division for the conservation and management of the forests.

Sriharikota Island is important from the biodiversity point of view as it has the last remaining, largest and best-preserved tracts of coastal Tropical Dry Evergreen Forest in India. The forest has had a long history of systematic clear-felling for fuel wood and timber, starting with the British Era. Plantations of Eucalyptus (*Eucalyptus* spp.), Casuarina (*Casuarina equisetifolia*), and Cashew (*Anacardium occidentale*) have been raised over the years by the Forest Department and settlers, now covering approximately more than 20% of the landmass. After the establishment of the SDSC-SHAR in 1969, its Conservation and Landscape Division continued raising plantations for afforestation in bare and degraded areas, creation of shelter belts, revenue, and for work generation for the tribals. *Acacia auriculiformis* was also introduced on a small scale in the 1970s. The invasive *Prosopis juliflora* has proliferated in some areas, especially along the western edge of the Island that borders Pulicat Lake and towards the southern parts of the Island. Another invasive, cane *Calamus rotang*, introduced during the late 19th century by the British, has colonised the edges of freshwater bodies and water courses. Patches of abandoned coconut, tamarind, mango, and palmyra (now overgrown with native vegetation) planted by the former settlers are seen, especially in the southern tracts of the Island. Besides these, there are extensive grasslands with scattered shrubs and trees in the southern part of the Island, and remnants of mangrove and salt marsh vegetation along the western edge of the Island. Due to the varied ecological conditions, and past and present anthropogenic factors, the structure of the vegetation is diverse. Information on the four habitat/vegetation types where the mammals were sampled is given below:

Tropical Dry Evergreen Forest: Tropical Dry Evergreen Forests (TDEF) are largely found in the central and northern part of the Island, stretching from south of Urugayya lake till north of Beripeta, except in sandy tracts or areas under plantations. The tree species include *Syzygium cumini*, *Pterospermum canescens*, *Manilkara hexandra*, *Garcinia spicata*, *Strychnos nux-vomica*, *Pongamia pinnata*, *Tamarindus indicus*, and *Cordia dichotoma.* The shrub layer includes *Memecylon umbellatum*, *Glycosmis pentaphylla*, *Eugenia bracteata*, *Grewia rhamnifolia*, and *Breynia vitis-idaea*. Climbers such as *Abrus precatorius*, *Asparagus racemosus*, *Cissus vitiginea*, *Jasminum* spp., *Carissa spinarum*, *Olax scandens*, *Coccinia grandis*, and *Ziziphus oenoplia* make the forest dense and impenetrable. Herbs are mainly restricted to the open patches in the forests. Along streams and shallow basins, which are inundated during the monsoon, *Terminalia arjuna*, *Barringtonia acutangula*, and *Pongamia pinnata* are dominant; *T. arjuna* occurs in pure stands at some sites. Canebrakes line most of the waterways. The overall mean canopy cover in TDEF is *c.* 69%, and the shrub cover is *c.* 59% (Manakadan and Sivakumar 2004).

Open Scrub: Open scrub is largely present in the sandy tracts of the Island, which occur in the northern, eastern, and southern fringes of the Island. There is also a sandy tract in the central part of the Island. The soil is sandy and much exposed, with predominance of shrubs like *Gmelina asiatica*, *Diospyros ferrea*, *Securinega leucopyrus*, *Catunaregam spinosa*, *Canthium parviflorum*, *Maytenus emarginatus*, *Dodonea viscosa*, *Capparis* spp., *Carissa spinarum*, *Pavetta indica*, and *Atalantia monophylla.* Scattered trees of *Syzygium cumini*, *Sapindus emarginatus*, *Lannea coromandelica*, *Ficus* spp., *Azadirachta indica*, *Albizzia amara*, *Walsura trifolia*, *Pamburus missionis*, and *Ochna obtusata* occur. The overall mean canopy cover in open scrub is *c.* 1%, and the shrub cover is *c.* 37% (Manakadan and Sivakumar 2004).

Eucalyptus Plantation: Eucalyptus plantations are mainly seen from about Urugayya lake to the north of Beripeta. Shrubby elements, such as *Memecylon umbellatum*, *Securinega leucopyrus*, *Catunaregam spinosa* and *Atalantia monophylla*, form the undergrowth. An understorey of *Strychnos nux-vomica*, *Garcinia spicata*, and *Ochna obtusata* has come up in some of the more open plantations. Eucalyptus plantations have a high mix (80%) of native vegetation, considering the density of both trees (middle storey) and shrubs. This high proportion of native species in eucalyptus is because the plantations in Sriharikota are primarily raised as part of afforestation schemes and not for revenue generation, and hence, are not strictly managed as in commercial plantations. The overall mean canopy cover in eucalyptus plantation is *c.* 55%, and the shrub cover is *c.* 33% (Manakadan and Sivakumar 2004).

Casuarina Plantation: Casuarina plantations are mostly seen as a narrow belt along the coast. Unlike eucalyptus, casuarina plantations form dense, pure stands without much mixture of native species. In open patches, shrubs and trees like *Securinega leucopyrus*, *Azadirachta indica*, *Pavetta indica*, *Ochna obtusata*, *Calotropis gigantea*, *Cassia auriculata*, and *Borassus flabellifer* occur. *Olax scandens* is a common climber, while *Dendrophthoe falcata* (=*Loranthus longiflorus*) is a common stem parasite on casuarina trees. Remnants of groves of casuarina (planted by the former settlers) are seen in some of the interior areas of the Island and in the southern part from Tettipeta to Karimanal. Unlike eucalyptus, casuarina occurs in almost pure stands with low (35%) mix of native vegetation, these almost totally constituting the shrub layer. The growth of native vegetation is poor in casuarina plantations, as besides the lack of shade due to dense planting, the litter of bristles forms a dense carpet on the forest floor, restricting the growth of seedlings. The overall mean canopy cover in casuarina is *c.* 80%, and the shrub cover is *c.* 15% (Manakadan and Sivakumar 2004).

METHODS

Inventory Surveys: During the first three months (November 2001 to January 2002) of the study, we carried out extensive surveys throughout the Island on foot and motorcycle during the day and night to make a checklist of mammals, and record general information on species and their habitats. The locals, especially the Yanadi tribals, were interviewed, mainly to obtain information on the past status, distribution, and populations of mammals in the Island. Further to this, regular day and night sampling (discussed below) was carried out in the northern and central areas of the Island; the southern areas were subject to only occasional surveys due to difficult logistics.

Diurnal Mammals: Transects were used for surveying diurnal mammals. Sampling was carried out between 07:30–08:30 hrs in 10 one km transects in each of the four habitat types (namely tropical dry evergreen forest (TDEF), open scrub, eucalyptus, and casuarina). All the 10 transects were walked during the summer and winter/wet seasons of 2002–2003, and only five of these were covered during 2003–2004 seasons. Animals seen on either side of transects were recorded and encounter rates (number/km) of species was calculated for each habitat type.

Nocturnal Mammals: Surveys of nocturnal mammals were carried by roadside counts along a 21.2 km stretch of road covering TDEF (5.1 km), open scrub (3.9 km), eucalyptus (3.6 km), casuarina (3.0 km), and also mixtures of some of these, namely TDEF-open scrub (2.7 km) and TDEF-eucalyptus (2.9 km). The extent of each vegetation type was estimated using the kilometre reading in the motorcycle's speedometer. This stretch was sampled between 20:00 hrs and 21:00 hrs once a fortnight from March 2003 to February 2004, thus sampling it 24 times. Only animals seen in the headlights of the motorbike within a distance of 3 m on either side of the road were recorded. The pillion rider carried a 4-cell torch for confirmation of the identity of the animal. Encounter rates (number/km) of species was calculated for each habitat type.

Statistical Analysis: We used the Mann-Whitney non-parametric test (SPSS, Version 13) to determine the significance of differences in encounter rates of common species in the different habitat types, mostly pooled for natural habitat and plantation. Due to low records for the other species, statistical tests were not carried out and only their encounter rates are given.

RESULTS

A total of 28 species of mammals were recorded in Sriharikota through the inventory surveys, transect surveys, and roadside surveys (Table 1). These consisted of 2 species of primates, 3 species of cats, 1 species of canid, 2 species of shrews, 7 species of bats, 8 species of rodents, and 1 species each of mongoose, civet, deer, pig, and anteater. The record of the anteater was based on reports of locals.

Table 1: Checklist of the mammals of Sriharikota

S. No.	Species	Remarks
1.	Bonnet Macaque *Macaca radiata* (Geoffroy)	Common in TDEF and abandoned village forest. Rare in eucalyptus and especially casuarina plantations, and in the southern grassland areas.
2.	Grey Slender Loris *Loris lydekkerianus* (Linn.)	Not uncommon in TDEF and casuarina plantations. Very rare in open scrub and the southern grassland areas.
3.	Leopard *Panthera pardus* (Linn.)	Record based only on pugmarks recorded during April and May 2007. A dead animal found in the adjoining Pulicat lake during June 2001 (Kannan and Manakadan 2004). The species is otherwise not known to occur in the Island. These two animals probably came from the Eastern Ghats forests.
4.	Jungle Cat *Felis chaus* (Guldenstaedt)	Record based only on a road-kill in December 2002. Yanadi tribals report it to be much less common than the Rusty-spotted Cat, and is said by locals to prey on domestic fowl.
5.	Rusty-spotted Cat *Prionailurus rubiginosus* (Geoffroy)	Occasional. Five records. A road kill near the former Penubakkam Colony, a sighting during night census in eucalyptus plantation during October 2002, two sightings of a male on consecutive days at the same site in TDEF during October 2002, and sighting of an immature in a casuarina plantation during night census in November 2002. Traditionally hunted by Yanadis for the pot as in the case of the Small Indian Civet.
6.	Small Indian Civet *Viverricula indica* (Desmarest)	Common and traditionally hunted by Yanadis. About a dozen sightings spread almost throughout the Island (except casuarina plantations) during night census. The only record during the day was of an individual sleeping under low dense foliage of a cashew tree.
7.	Common Indian Mongoose *Herpestes edwardsi* (Geoffroy)	Common and recorded in all the habitat types; sightings more common in open habitat in the southern areas of the Island. Species recorded during day and night census, indicating it is both diurnal and nocturnal in habits.
8.	Golden Jackal *Canis aureus* (Linn.)	The most commonly seen large mammal in Sriharikota, even wandering near residential areas. Taken to scavenging canteen wastes of facilities after nightfall. Cubs were recorded on a few occasions during summer. A major predator of sea turtle nests on the beach.
9.	Asian House Shrew *Suncus murinus* (Linn.)	Not uncommon in residential areas; recorded thrice in forest areas.
10.	Etruscan Shrew *Suncus etruscus* (Savi)	Frequently caught in pitfall traps; more common in eucalyptus plantations. Not recorded in residential areas.
11.	Indian Flying Fox *Pteropus giganteus* (Brunnich)	A decades old colony of about 400–500 bats recorded east of the bridge over the Malliplate Wagu. The bats occasionally shift to nearby areas (including casuarina plantations on the coast) when disturbed by the activities of fishermen. More than 3,000 counted and another roost with 350–400 bats recorded in the central part of the Island Telemetry-I during the second project, these are probably seasonal migrants to the Island.
12.	Greater Short-nosed Fruit Bat *Cynopterus sphinx* Vahl	Regularly recorded feeding on fruit trees in residential areas. Yanadis report it to roost in small groups in palm trees in the forest.
13.	Dusky Leaf-nosed Bat *Hipposideros ater* (Templeton)	Roosts (*c.* 25 animals) recorded at two culverts near Penubakkam.
14.	Schneider's Leaf-nosed Bat *H. speoris* (Schneider)	Roosts (*c.* 200 animals) recorded in an abandoned temple on the road to Rayadurg and in an underground cable junction box (20–30 animals) along the SRC road.
15.	Greater False Vampire *Megaderma* (*Lyroderma*) *lyra* (Geoffroy)	Roosts (*c.* 200 animals) along with the Schneider's Leaf-nosed Bat in an abandoned temple on the road to Rayadurg.
16.	Greater Asiatic Yellow House Bat *Scotophilus heathii* (Horsfield)	A dead specimen collected in the Phase-I residential area. Many individuals were seen emerging in the evenings from the Phase-II residential areas and foraging in adjoining open areas.
17.	Little Pipistrelle *Pipistrellus* (*Pipistrellus*) *coromandra* (Gray)	Regularly observed flying and hawking for insects under floodlights of residential areas, sometimes entering houses.
18.	Indian Palm Squirrel *Funambulus* (*Funambulus*) *palmarum* (Linn.)	Common throughout the Island with high densities in TDEF and in trees in open scrub. Also common in residential areas.
19.	Lesser Bandicoot Rat *Bandicota bengalensis* (Gray & Hardwicke)	Yanadis, who traditionally hunt the species for food, say that it was much more common earlier when crops were grown on the Island. A few burrows recorded near the edges of the Penubakkam Badava.

Table 1: Checklist of the mammals of Sriharikota (*contd.*)

S. No.	Species	Remarks
20.	Little Indian Field Mouse *Mus* (*Mus*) *booduga* (Gray)	Record based on a pair caught by a Yanadi near an abandoned irrigation pond on the outskirts of the former Penubakkam Colony.
21.	Indomalayan Vandeleuria *Vandeleuria oleracea* (Bennett)	Nests recorded twice, once in the peeling bark of a eucalyptus tree and another inside the half-peeled bark of a dead *Acacia auriculiformis* tree. Also frequents human dwellings.
22.	Indian Gerbil *Tatera indica* (Hardwicke)	Appears to be common judging by frequent records of road kills and sightings during roadside census at night. Eaten by Yanadis.
23.	Roof Rat *Rattus rattus* (Linn)	Recorded twice in residential colonies; reported to have been common in the former settlement colonies in the forest.
24.	Greater Bandicoot Rat *Bandicota indica* (Bechstein)	Common in residential areas and is also reported to occur in forest areas.
25.	Indian Hare *Lepus* (*Indolagus) nigricollis* F. Cuvier	Recorded largely in open scrub habitats and is probably more abundant in the southern open grassland areas.
26.	Chital *Axis axis* (Erxleben)	Reported by locals to have entered the Island during the 1984 major cyclone. Population estimated at >200 animals. Four sightings, the largest of a herd of more than a dozen animals.
27.	Wild Boar *Sus scrofa* (Linn)	Widely distributed in all habitats, but partial to the edges of water bodies. It is a major predator of sea turtle nests on the beach. The species was a favourite quarry of Yanadis and former settlers.
28.	Indian Pangolin *Manis* (*Manis*) *crassicaudata* Gray	Reported by locals to have entered the Island during the major cyclone of 1984. Only two records: one killed by Yanadis immediately after the cyclone, the other a sighting by an ISRO employee, of an animal crossing a forest road during the 1990s.

Mammals recorded from transect surveys during the day: A total of nine species of mammals were recorded in the four habitat types (Table 2). The Bonnet Macaque *Macaca radiata* and Common Indian Mongoose *Herpestes edwardsii* were recorded only in the natural habitat (TDEF and open scrub) and not in plantations (eucalyptus and casuarina). The encounter rate of the Indian Palm Squirrel *Funambulus palmarum* was significantly higher in natural habitat than in plantations (Mann-Whitney U=1067, $p<0.001$), and within the natural habitat, it was significantly higher in TDEF than in open scrub (Mann-Whitney U=288.0, $p<0.05$). There were a few records of the other species, some of which were more frequently recorded during the night surveys (Table 2).

Mammals recorded from roadside surveys at night: A total of nine mammal species were recorded during roadside surveys at night in the six habitat types (Table 3). The Indian Hare were encountered more in open scrub than in the other three habitat types (Table 3). The Small Indian Civet *Viverricula indica* and Common Indian Mongoose were only recorded in natural habitats. The encounter rates of the Golden Jackal *Canis aureus* and Indian Hare *Lepus* (*Indolagus*) *nigricollis* were higher in natural habitat than in plantations (Mann-Whitney U=1390, $p<0.01$ and U=1536, $p<0.05$, respectively), but within the natural habitat, the Indian Hare

Table 2: Encounter rate (no./km) of mammal species in the vegetation types recorded during transect surveys during the day (n=30 transects/habitat type)

Species	TDEF	Open Scrub	Eucalyptus	Casuarina
Bonnet Macaque	0.30 (0.08) 9	0.03 (0.03) 1	-	-
Grey Slender Loris	-	-	-	0.03 (0.03) 1
Small Indian Civet	0.03 (0.03) 1	-	-	-
Common Indian Mongoose	0.20 (0.10) 4	0.01 (0.07) 1	-	-
Golden Jackal	0.10 (0.07) 2			0.07 (0.07) 1
Indian Palm Squirrel	2.0 (0.33) 24	1.1 (0.24) 16	0.43 (0.12) 9	0.63 (0.13) 9
Indian Hare	-	0.07 (0.05) 2	0.03 (0.03) 1	-
Spotted Deer	0.06 (0.05) 3	0.07 (0.05) 3	- -	- -
Wild Boar	0.1 (0.06) 2	-	0.27 (0.23) 2	0.06 (0.05) 2

Values are encounter rates with standard error (in parenthesis), followed by frequency of occurrence (n=30 transects/habitat type)

Table 3: Encounter rate (no./km) of mammal species in the vegetation types during roadside surveys at night (n=24)

Habitat / Species	TDEF	TDEF-Open Scrub	Open Scrub	TDEF-Eucalyptus	Eucalyptus	Casuarina
Slender Loris	0.008 (0.008)	0.03 (0.02)	0.02 (0.01)	-	0.01 (0.01)	-
Rusty-spotted Cat	-	-	-	-	0.01 (0.01)	0.01 (0.01)
Small Indian Civet	0.03 (0.01)	0.11 (0.05)	0.02 (0.01)	- -	- -	- -
Common Indian Mongoose	-	0.02 (0.02)	0.01 (0.01)	- -	- -	- -
Golden Jackal	0.19 (0.08)	0.17 (0.10)	0.13 (0.06)	0.14 (0.06)	0.07 (0.03)	- -
Indian Gerbil	0.07 (0.03)	0.62 (0.16)	0.47 (0.09)	0.47 (0.18)	0.30 (0.07)	0.36 (0.08)
Indian Hare	-	0.06 (0.04)	0.10 (0.04)	0.01 (0.01)	- -	- -
Wild Boar	-	0.22 (0.16)	0.03 (0.02)	- -	- -	0.23 (0.03)

Values are the encounter rates with standard error (within parenthesis)

was not recorded in dense TDEF stands. There was no clear trend in the encounter rates of Indian Gerbil between the natural habitat and plantations (Mann-Whitney U=1697, p=0.86). There were a few records of the other species (Table 3) – these require specific sampling to obtain sufficient records for meaningful analysis.

DISCUSSION

The surveys revealed the presence of 28 mammal species in Sriharikota Island, almost all of which are common and widely distributed in India. The study also revealed that the Island has a good population of the Grey Slender Loris *Loris lydekkerianus*. The Grey Slender Loris is endemic to India and Sri Lanka; its distribution range in India is in the peninsular region south of rivers Tapti in the west and Godavari in the east (Groves 2001; Manakadan and Sivakumar 2005; Roonwal and Mohnot 1977). The species has been classified under Schedule I of the Indian Wildlife (Protection) Act 1972 and in the Vulnerable category by IUCN (2000). The population of the species in Sriharikota was estimated at 250–300 individuals (Sivakumar and Manakadan 2008). Another species of interest is the arboreal Rusty-spotted Cat *Prionailurus rubiginosus*. Earlier considered to be confined to south-western India, there have been sightings from other areas, since the 1970s. Very little is known of its ecology and habitat, which is reported to range from grassland, scrub and forest, rocky outcrops, areas around human habitation, and even in house attics (Jackson1998; Manakadan and Sivakumar 2005; Mukherjee 1998).

Overall, the study revealed that the encounter rates of mammals were higher in natural habitats than in plantations. Mammalian species that seem to be directly affected by replacement of TDEF with plantations are the Bonnet Macaque and Indian Palm Squirrel, which mostly feed on fruits, seeds, and shoots. TDEF and open scrub, due to the diversity of herbs, shrub, climber and tree species, offer a variety of food plants for these and other mammal (and bird) species during different seasons (David *et al*. 2008). The Bonnet Macaque was not recorded in plantations. Among the nocturnal mammals, the encounter rates of most of the relatively common nocturnal mammals (namely, Golden Jackal, Common Mongoose, Small Indian Civet, and Indian Hare) were higher in natural forest than in plantations. Though the encounter rate for Grey Slender Loris was low in TDEF during the road surveys at night, the maximum incidental records obtained of the species during herpetofaunal sampling at night was in TDEF (Manakadan and Sivakumar 2004). This suggests that roadside surveys are not effective for sampling of Grey Slender Loris, probably since it avoids habitats near roads, perhaps due to the break in canopy contiguity and human disturbance.

A number of studies (Evans 1992; Fogarty and Vilella 2003; Gandhi 1986; Singh *et al*. 1999) have shown that plantations are detrimental to wildlife. However, the Grey Slender Loris was recorded to inhabit mature casuarina plantations in Sriharikota that had snags, fallen logs, and litter – probably as these conditions provided rich habitat for its prey species. The Grey Slender Loris is predominantly insectivorous, with ants and termites constituting a considerable proportion of its diet (Nekaris and Jayewardene 2004; Radhakrishna and Singh 2002a, b). Our studies on herpetofauna (Sivakumar and Manakadan 2004) in Sriharikota revealed significantly higher abundance of skinks and geckos in mature casuarina plantations, suggesting a higher abundance of insect fauna in them. Casuarina plantations also have good canopy contiguity, which is vital for the survival of this slow, arboreal species.

The Wild Boar *Sus scrofa* was recorded occasionally venturing into and around casuarina plantations along the coast to feed on crabs and sea turtle nests – as indicated by their digging. The Golden Jackal also raids turtle nests and scavenges on the shore, and probably got recorded in the adjoining casuarina plantations primarily for this reason. There was no clear trend in the encounter rate of the Indian Gerbil between natural habitats and plantations. It was mostly recorded at night along roads during the roadside surveys – it also topped the numbers of road-kills for mammals in Sriharikota (Sivakumar and Manakadan 2010). In casuarina plantations, it was recorded only at sites which were bare and had the cover of *Ziziphus mauritiana* shrubs. Otherwise, all the above mentioned three species appeared to be scarce in casuarina plantations.

A major reason for mammals occurring in the plantations in Sriharikota is that these are not actively managed since they were raised primarily for afforestation and shelter-belts. Thus, the mature plantations have a mix of native species, especially as the shrub and understorey layers. In many areas, eucalyptus trees have declined in numbers (uprooted during cyclones) and the gaps have been filled by native plants. Another factor that may have contributed to higher than expected abundances of mammal species in plantations is the impact of edge effects, since plantations have contiguity with either TDEF or open scrub. Plant and animal diversities are known to be higher at the edges (compared to interiors) of remnant vegetation (Angelstam 1992; Yahner 1988). Edge effects were greater in casuarina as these plantations comprise a narrow strip (*c.* 300 m wide) along the seashore and are largely bordered by scrub vegetation on the west.

Another reason for higher encounter rates in casuarina plantations (and also in open scrub) than in TDEF (and to a lesser extent in eucalyptus plantations) was the dense cover in TDEF. Ideally, we should have carried out distance sampling, which would have addressed the issue of variable detection probability across habitat types, and arrived at comparable abundance/density estimates (*vs.* encounter rates) of species, but the project involved enumerating the faunal diversity of taxa ranging from butterflies, fish, herpetofauna, birds to mammals, and had manpower and time constraints for undertaking this. As stated earlier, the objective of the project was to make an inventory of the faunal diversity of the Island and to provide basic information on their status, population, and distribution.

CONCLUSION

Sriharikota, by virtue of having one of the last remaining, largest, and well-protected tract of tropical dry evergreen forest in India, serves as an important biodiversity conservation site for this forest type. Moreover, with India's rapid and alarming biodiversity loss in recent times, sites like Sriharikota with limited human pressures could become especially significant for biodiversity conservation in the future. However, the general trend in India, and in Sriharikota (till our studies), is that formations lacking in timber species are as a rule considered useless and felled or replaced with plantations, little realising that these have rich diversity and are repositories of economic-medicinal plants and natural habitat for wildlife (Meher-Homji 1997, 2001). Besides the issue of plantations, the rapid expansion of the spaceport in recent years, which has involved and will further involve the cutting down of forests for construction of buildings and other facilities, is a cause of concern. ISRO needs to take a judicious view of future expansion and development of the spaceport to ensure that the conservation of the forests of Sriharikota and its wildlife are also addressed.

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DIVERSITY AND ABUNDANCE OF RODENTS IN THE SEMI-ARID LANDSCAPE OF SARISKA TIGER RESERVE, WESTERN INDIA

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The diversity and abundance of rodents were estimated in Sariska Tiger Reserve, Rajasthan, from November 2007 to June 2009. A total of 41 Sherman traps were deployed at twelve sites under different vegetation types for 10 days during winter and summer, which amounted to a total effort of 4,920 trap nights and recorded eleven species of small rodents. The diversity of rodents was found to be highest in open scrub in winter, and in summer it was highest in *Ziziphus* mixed forest. Overall (combining both summer and winter), *Mus platythrix* was found to be most abundant (6.26 individuals/ha), followed by *Golunda ellioti* (3.41 individuals/ha). The overall rodent density was 22.92 ±4.65 (SE) animals/ha in winter, and 7.81 ±2.25 (SE) animals/ha in summer.

Key words: Rodents, density, semi-arid landscape, Sariska Tiger Reserve, Web trapping design

INTRODUCTION

The rodents of the Indian subcontinent are represented by 46 genera and 128 species (Ellerman 1961; Roonwal 1987). They are generally viewed as pests due to the economic losses caused to agriculture and the prospect of their being carriers of disease (Mukherjee *et al.* 2004). However, the importance of rodents in the diet of many large and small carnivores has been documented by various studies (Comman and Brunner 1972; Gupta 2006, 2011; Jones and Smith 1979; Kitchener 1991; Ludlow and Sunquist 1987; Moehlman 1986; Mondal *et al.* 2011; Mukherjee 1998; Palmer and Fairall 1988; Pearson 1964; Sankar and Johnsingh 2002; Sankar *et al.* 2009; Sillero-Zubiri and Gottelli 1995). In the recent past, many workers have contributed to an understanding of the distribution pattern of rodents in India. Chakraborty (1983) studied the rodent distribution in Jammu & Kashmir region. Mahajan and Mukherjee (1972, 1974) prepared a checklist of rodents in Himachal Pradesh. Sood and Dilber (1977) documented the rodent species of Punjab. Sheiker *et al.* (1983) and Jain (1975) studied the rodents of Uttar Pradesh. The rodents of the Thar Desert in Rajasthan was studied in detail by Agarwal (1976), Biswas and Ghose (1968), Ghose (1976), and Prakash (1959, 1963, 1972, 1974, and 1981). Hill (1958), Jain (1985), and Khajuria and Ghosal (1981) documented the rodent fauna of Madhya Pradesh. Pradhan (1975) provided an account of the rodents of Maharashtra. Agarwal (1973) gave a detailed account of the rodent species of the Goa region. Agarwal and Bhattacharyya (1987) supplemented our knowledge of rodent distribution in West Bengal. Agarwal and Bhattacharyya (1977) and Roonwal (1949, 1950) made remarkable contributions to the rodent distribution of North-east India. A sum total of these efforts came out as compilations and Ellerman and Morrison Scott (1966) published a checklist of Indian rodents. But these were taxonomic studies and have not assessed the ecological aspects of species assemblage, co-existence, and diversity in the natural habitat.

Although numerous studies have investigated the distribution, behaviour, ecology, and management of rodents in agricultural fields (Advani and Mathur 1982; Alibhai 1985; Chopra and Gupta 1987; Chopra *et al.* 1996; Davis 1953; Prakash and Prakash 1985; Prakash and Mathur 1987; Rana 1992; Santra and Manna 2008; Spillett 1968; WHO 1974), only a few studies had investigated population of rodents in forested landscape in Rajasthan deserts (Prakash 1981, 1995). In this paper, we discuss the diversity and abundance of rodents in different vegetation types in the semi-arid landscape of Sariska Tiger Reserve, Rajasthan, assessed by the web trapping design method.

STUDY AREA

Sariska Tiger Reserve (STR), (25° 5'–27° 33' N; 74° 17'–76° 34' E) is situated in the Aravalli Hills range and lies in the semi-arid region of Rajasthan (Fig. 1). The Reserve is spread over 881 sq. km, of which 274 sq. km is notified as a national park. There are 30 villages in the Reserve and 10 in the National Park. The vegetation is tropical dry deciduous forest and tropical thorn forest (Champion and Seth 1968). The climate is subtropical, characterised by a distinct winter

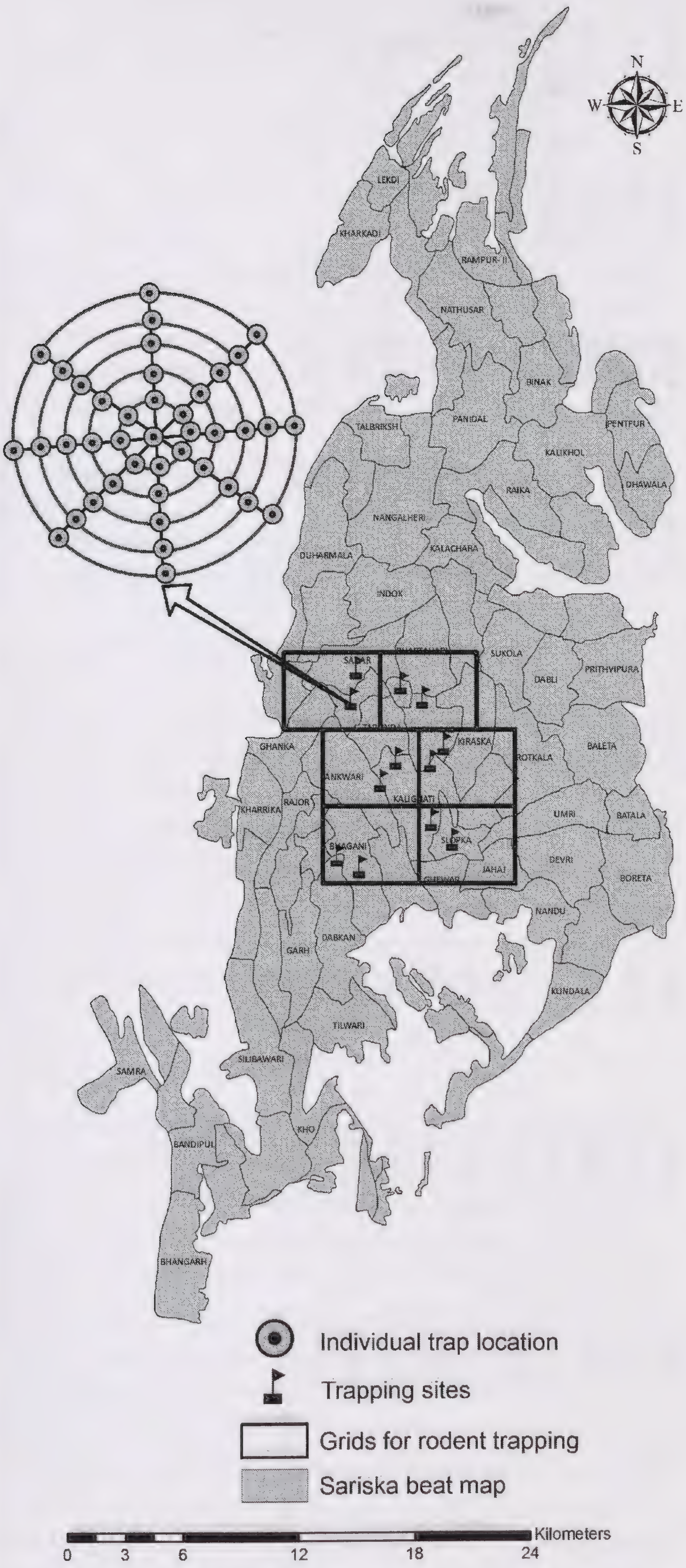

Fig. 1: Location of Sariska Tiger Reserve and the sampling sites in Intensive Study Area

(October–February), summer (March–June), and monsoon (July–September). The average annual rainfall is 700 mm, mostly received during July–September. Large carnivores are Tiger *Panthera tigris*, Leopard *Panthera pardus*, and Striped Hyena *Hyaena hyaena*, while the small carnivores include Caracal *Caracal caracal*, Golden Jackal *Canis aureus*, Jungle Cat *Felis chaus*, Common Mongoose *Herpestes edwardsi*, Small Indian Mongoose *Herpestes auropunctatus*, Ruddy Mongoose *Herpestes smithi*, Palm Civet *Paradoxurus hermaphroditus*, Small Indian Civet *Viverricula indica*, Ratel *Mellivora capensis*, and Desert Cat *Felis silvestris*.

METHODOLOGY

The study was conducted in an area of 120 sq. km of the National Park, divided into six blocks of 20 sq. km (Fig. 1). The diversity and abundance of rodents was estimated using the web trapping design (Anderson *et al.* 1983), which requires rodent captures to be collected from the trapping web, and treats the data (capture occasions and locations) as distance measures from the centre of the web.

Two trap points were randomly selected in each block. Thus, there was a total of 12 trapping sites for the six blocks. Forty-one standard Sherman live traps (5 x 6.5 x 16.5 cm) were placed at each trap points encompassing different vegetation types. Each Sherman live trap ran for ten consecutive trap nights (a trap night denoting the use of one trap/night), and thus, the total sampling amounted to 4,920 trap nights/season. The traps were operated in 0.79 ha, having concentric rings of 5 traps each at intervals of 10 m covering 50 m radius (Fig. 1). Traps were placed on the forest floor and concealed with bushes and dry leaves. All traps were painted brown, and placed near bushes, trees, rocks, fallen logs, or any other possible runways of rats. All the traps were baited with peanut butter, placed between 17:30–18:30 hrs, and checked for animals between 5:30–7:30 hrs. Equal efforts were made in all the blocks in both the seasons. Trapping success was calculated from the number of rodents captured divided by the number of trap nights.

The trapped rodents were photographed and identified, weighed and measured for tail length and body to head length (HBL). Rodents were identified up to species level using field guides (Corbett and Hill 1992; Menon 2003; Prater 1980). Sex was identified based on their genitalia; adults, subadults, and pregnant females were not identified separately. The animals were released at the spot where they had been trapped.

Simpson's Index (d) was used to evaluate species richness at the different trap sites. The Shannon Wiener diversity and evenness indices were used to estimate the species diversity across the trap sites (Shannon and Wiener 1963). The trapping web design was used for estimation of abundance of different rodent species (Burnham *et al.* 1980), while the program DISTANCE 5.0 (Laake *et al.* 1994) was used for computations of seasonal (summer and winter) densities in the different sites. Each dataset was analysed by three different models

Table 1: Species richness (Simpson's Index) and species diversity (Shannon Wiener Index) of rodent species in different trap sites in Sariska Tiger Reserve during November 2007–June 2009

Trap sites	Winter					Summer				
	Number of species (S)	Species diversity (Shannon Wiener index-H)	Species richness		Evenness $(E) = e^{H/s}$	Number of species (S)	Species diversity (Shannon Wiener index-H)	Species richness		Evenness (E) $(E) = e^{H/s}$
			Simpson's index of diversity=(1-d)	Simpson's reciprocal index=(1/d)				Simpson's index of diversity=(1-d)	Simpson's reciprocal index=(1/d)	
Riverine F	6	1.364	0.656	2.907	0.652	5	1.458	0.746	3.930	0.859
Riverine-*Ziziphus* F	7	1.837	0.826	5.730	0.896	1	0.000	0.000	1.000	1.000
Acacia W	2	0.683	0.498	1.960	0.989	2	0.636	0.444	1.799	0.945
Acacia MF	2	0.451	0.278	1.384	0.784	3	1.040	0.625	2.667	0.943
Anogessius W	3	0.901	0.531	2.133	0.820	3	1.011	0.611	2.571	0.916
Anogessius MF	3	1.030	0.620	2.631	0.933	3	1.040	0.625	2.667	0.943
Ziziphus MF	4	0.610	0.283	1.393	0.460	6	1.696	0.800	5.000	0.908
Ziziphus W	1	0.000	0.000	1.000	1.000	3	1.055	0.640	2.778	0.957
Open Scrubland	8	1.789	0.783	4.613	0.784	4	1.360	0.732	3.805	0.974
Scrubland-*Acacia* W	9	1.993	0.837	6.154	0.815	0	—	—	—	—
Butea MF	4	1.303	0.703	3.368	0.920	3	0.678	0.380	1.614	0.656
Butea-Ziziphus MF	2	0.377	0.219	1.280	0.729	1	0.000	0.000	1.000	1.000

F= Forest, W= Woodland, MF= Mixed forest

Table 2: Overall density estimates of rodent species during November 2007–June 2009 in Sariska Tiger Reserve

		Overall				
S. No	Species	N	Density/ ha	SE	Encounter rate	SE
1	*Golunda ellioti*	67	3.41	0.66	0.279	0.044
2	*Vandeleuria oleracea*	12	0.61	0.26	0.050	0.021
3	*Mus booduga*	21	1.06	0.30	0.087	0.022
4	*Mus musculus*	18	0.92	0.27	0.075	0.020
5	*Mus platythrix*	123	6.26	1.07	0.510	0.065
6	*Millardia gleadowi*	11	0.52	0.19	0.045	0.014
7	*Millardia meltada*	4	0.20	0.10	0.016	0.008
8	*Rattus norvegicus*	25	1.27	0.30	0.104	0.022
9	*Rattus rattus*	14	0.71	0.23	0.058	0.018
10	*Tatera indica*	16	0.81	0.27	0.066	0.020
11	*Gerbillus nanus indus*	5	0.25	0.11	0.020	0.009

N = Total number of captures

Table 3: Weight and body measurements of rodent species in Sariska Tiger Reserve

	Average weight (gm)		Head to body length (cm)		Tail length (cm)	
Species	Female	Male	Min.	Max.	Min.	Max.
Golunda ellioti	41.7	53.7	6.5	12.1	7.3	12.1
Vandeleuria oleracea	16.0	18.9	4.5	7.0	9.0	11.5
Mus booduga	8.3	7.3	4.3	6.8	5.0	8.5
Mus musculus	7.8	8.8	4.0	7.2	4.7	11.3
Mus platythrix	15.3	13.7	4.3	7.8	5.1	9.1
Millardia gleadowi	54.5	52.0	8.2	11.5	8.0	15.5
Millardia meltada	66.8	68.0	7.1	11.5	9.0	17.0
Rattus norvegicus	108.8	124.9	9.2	20.0	16.0	21.0
Rattus rattus	135.1	134.9	12.5	17.3	18.6	23.5
Tatera indica	54.3	50.2	8.2	13.5	10.2	20.5
Gerbillus nanus indus	23.5	14.5	7.0	8.7	10.5	13.5

* Min. = minimum; Max. = maximum

(uniform, half-normal, and hazard) with three possible model adjustments (cosine, polynomial, and hermite). Akaike's information criterion was used to select the model that best fit the present dataset (Buckland *et al.* 1993). Z test was used to check for any significant difference in the densities of rodents between seasons (Zar 2004). Rodent biomass was calculated by multiplying the mean species body weight by estimated density of the species (Nichlos *et al.* 1975).

RESULTS

Species diversity and richness: The Shannon Wiener diversity and Simpson richness indices indicated high rodent species diversity in Open Scrubland, followed by *Acacia* woodland and Riverine Forest in winter (Table 1). In summer, the diversity and richness indices indicated high rodent species diversity in *Ziziphus* mixed forest and Riverine forest (Table 1). Species wise: *Vandeleuria oleracea* was captured only in *Anogessius* dominant forest; three species of *Mus* were recorded in open scrubland, *Ziziphus* woodland, and *Anogessius* mixed forest; two species of gerbils were captured in *Ziziphus* woodland and scrubland; *Rattus rattus*, *R. norvegicus*, and *Millardia meltada* were found in *Butea* mixed forest; *Millardia gleadowi* was captured only in *Butea-Ziziphus* mixed forest; and *Golunda ellioti* was largely captured in open scrubland.

Overall density: A total of 316 individuals belonging to 11 species of rodents were recorded during the study. The overall weight of male and female, average HBL, and average tail length of species is given in Table 3. The overall rodent density was 16.15 ±2.76 animals/ha, and their estimated total biomass was 612.9 gm/ha. Global detection model was fitted using the abundance of all species. Half normal detection function with cosine adjustment of order two was the best fitted model for all species. *Mus platythrix* was found to be the most abundant species (6.26 individuals/ha) in the study area, followed by *Golunda ellioti* (3.41 individuals/ha) and *Rattus norvegicus* (1.27 individuals/ha) (Table 2).

Seasonal density: Least trap success was recorded in summer (0.89%) and maximum trap success in winter (2.6%) (Table 4). The species detection was explained by half normal detection function with cosine adjustment of order two in summer and uniform with cosine of order two in winter, based on lowest Akaike information criterion. The overall rodent density in winter was 22.92 ±4.65 (SE) animals/ha, and 7.81 ±2.25 (SE) animals/ha in summer. Z test revealed significant difference in the densities of rodents between seasons (Z=2.915, P=0.0039). *Gerbillus nanus indus* was captured (n=5) only in summer, and *Millardia meltada* (n=5) only in winter.

Of the 316 captures of 11 species, *Mus platythrix* (n=127) was found to be the most abundant rodent species in both the seasons followed by *Golunda ellioti* (5.56 individuals/ha) in winter, *Golunda ellioti* (1.01 individuals/ha) and *Rattus norvegicus* (0.92 individuals/ha) in summer (Table 4).

DISCUSSION

The overall density of rodents in Sariska Tiger Reserve (STR) was low compared to those reported in some other tropical

Table 4: Density estimates of rodent species during winter and summer (2007–2009) in Sariska Tiger Reserve

	Winter (Nov–Feb)					Summer (Mar–June)				
	N	Density/ha	SE	EDR	SE	N	Density/ha	SE	EDR	SE
Golunda ellioti	56	5.56	1.2	0.466	0.08	11	1.01	0.4	0.091	0.028
Vandeleuria oleracea	11	1.09	0.5	0.091	0.04	1	0.09	0.09	0.008	0.008
Mus booduga	17	1.69	0.54	0.141	0.041	4	0.37	0.2	0.033	0.016
Mus musculus	12	1.29	0.45	0.108	0.035	6	0.46	0.26	0.041	0.021
Mus platythrix	91	9.04	1.77	0.758	0.11	32	2.95	0.99	0.266	0.064
Millardia gleadowi	5	0.49	0.22	0.041	0.018	6	0.55	0.28	0.05	0.023
Millardia meltada	4	0.39	0.2	0.033	0.016	0	–	–	–	–
Rattus norvegicus	15	1.49	0.47	0.125	0.036	10	0.92	0.35	0.083	0.025
Rattus rattus	7	0.69	0.33	0.058	0.027	7	0.64	0.31	0.058	0.024
Tatera indica	12	1.19	0.46	0.1	0.036	4	0.36	0.24	0.033	0.02
Gerbillus nanus indus	–	–	–	–	–	5	0.46	0.23	0.042	0.018

EDR= Effective distance radius; N = Total number of captures

deciduous forest areas in India: Kerala in Western Ghats (Jayahari 2008); upper Nilgiris, southern India (Shanker 2000, 2001, 2003; Shanker and Sukumar 1999). However, the trapping success of murid rodents in this study was high (2.8%) compared to an earlier study in Sariska (0.9%) by Mukherjee (1998).

There was a higher abundance of rodents in the study area during winter (6.33 animals/ha) than in summer (2.32 animals/ha), and this may be due to the congregation of rodents in the areas due to availability of seasonal fruits like *Ziziphus mauritiana*, *Z. nummularia*, and *Balanites aegyptiaca* that were observed to be consumed by them during winter. Prakash (1995) reported low abundance of rodents in summer in semi-arid areas of the Thar Desert in Rajasthan, where gerbils switch over their diet to insects when the vegetation is without water content. Prakash (1995) recorded spectacular fluctuation in feeding on various plant parts over the year (depending on their availability) for some rodent species in the desert ecosystem.

Rodents were found to play an important role in the diet of large, medium, and small-sized carnivores in STR, contributing 4.4% in the diet of Golden Jackal and 34.3% in Jungle Cat (Gupta 2011), and about 3–7% in the Leopard (Mondal 2011). A long-term study using web trapping design may give better understanding of rodent abundance in different habitat types and seasons in the study area, and also their contribution in small carnivores' diet in different seasons.

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THE STATUS OF THE GANGES RIVER DOLPHIN *PLATANISTA GANGETICA GANGETICA* IN THE RIVER BARAK, ASSAM, INDIA

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The Ganges River Dolphin *Platanista gangetica gangetica*, once common in the River Barak in southern Assam, is now rarely sighted. Currently, the dolphins in winter (December–February) congregate in a 14 km stretch of the Barak centring on two sites. During the rainy season (mainly June–August), they frequent tributaries and flooded paddy fields. The population in the 135 km stretch of the Barak, before its bifurcation near the Indo-Bangladesh border, was estimated at 14, 12, 10, 9, 9, 8, and 8 in 1999, 2001, 2003, 2005, 2006, 2007, and 2008, respectively. About 60%, 31%, and 9% of the population was made up of adults, subadults and calves respectively. Information on 29 dolphin mortalities in the Barak comprised 28% adults, 34% subadults and 38% calves. Fishing activities were responsible for 90% of the mortalities; 37% of deaths of calves were due to entanglement in gill-nets. Direct and indirect hunting, uses of dolphin oil as fish attractant and medicine, habitat loss and degradation, depletion of prey fish, water development projects, lack of people's awareness, and poor law enforcement threaten the dolphins. Among others, notification of Barak Dolphin Sanctuary and strict enforcement of laws are required to conserve the dolphins in the Barak.

Key words: Ganges River Dolphin, River Barak, population, mortality, habitat loss, conservation

INTRODUCTION

The Ganges River Dolphin *Platanista gangetica gangetica* and the Indus River Dolphin *Platanista gangetica minor* are two subspecies of the River Dolphin *Platanista gangetica* (Rice 1998). The Indus River Dolphin is found in the rivers of the lower Indus basin in Pakistan (Smith and Braulik 2008) and in the river Beas in Punjab, India (Behera *et al.* 2008). The Ganges River Dolphin is distributed in the Ganges-Brahmaputra-Meghna and Karnaphuli river systems of India, Nepal, and Bangladesh (Anderson 1879; Kasuya and Haque 1972; Jones 1982; Mohan 1989; Reeves and Brownell 1989; Reeves *et al.* 1993; Singha *et al.* 2007; Shrestha 1989; Wakid 2005). The Ganges River Dolphin is categorised as Endangered in the IUCN Red List (version 2009.1), and placed in Appendix I of CITES and in Schedule I of the Indian Wildlife (Protection) Act, 1972. A total of about 1,200–1,800 animals is a reasonable estimate of the lower range of its global population (Smith and Braulik 2008).

River Barak, the largest river of Manipur and southern Assam and the second largest river of north-east India, is the head stream of the Meghna and is, therefore, an integral part of the Ganges-Brahmaputra-Meghna (GBM) river system. As in many other rivers of the GBM river system, the dolphin, known to the people of Barak Valley (Cachar, Karimganj, and Hailakandi districts of Assam) as *Suins* in Hindi, *Foo Maachh* or *Hoohn* in the local dialect of Bengali, *Susuma* in Dimasa, and *Nasubi* in Manipuri, was once common, but is now rarely sighted in the Barak.

Published work on the dolphin in the Barak is scanty. Biswas (1995) reported its absence from its past strongholds in an 80 km length of the Barak. Choudhury (1997) mentioned its occurrence in the Barak in the checklist of the mammals of Assam. In November 1999, Singha (Anon. 1999) found dolphins of the Barak to congregate at Lalmati Dahr. Singha (2005) presented an overview of the dolphin and its occurrence in the Barak. Singha and Biswas (2005) reported on dwindling numbers of this dolphin in the rivers of southern Assam. Singha *et al.* (2007) gave insights into the past, present, and future survival of the species in the River Barak in Assam.

For planning and adoption of conservation measures, very few accounts on the whereabouts and population trend of the dolphin in the Barak are available. Therefore, population studies on the dolphins in the River Barak were done from 1999 to 2008, which form the basis of this paper.

MATERIAL AND METHODS

The study covered a stretch of 135 km (12 km in hill areas and 123 km in the plains) of the River Barak from Narain Dahr (24° 43' N; 93° 04' E), near the Assam-Manipur border to Tiganga (24° 52' N; 92° 29' E), the point of its bifurcation near the Indo-Bangladesh border (Fig. 1). The River Barak,

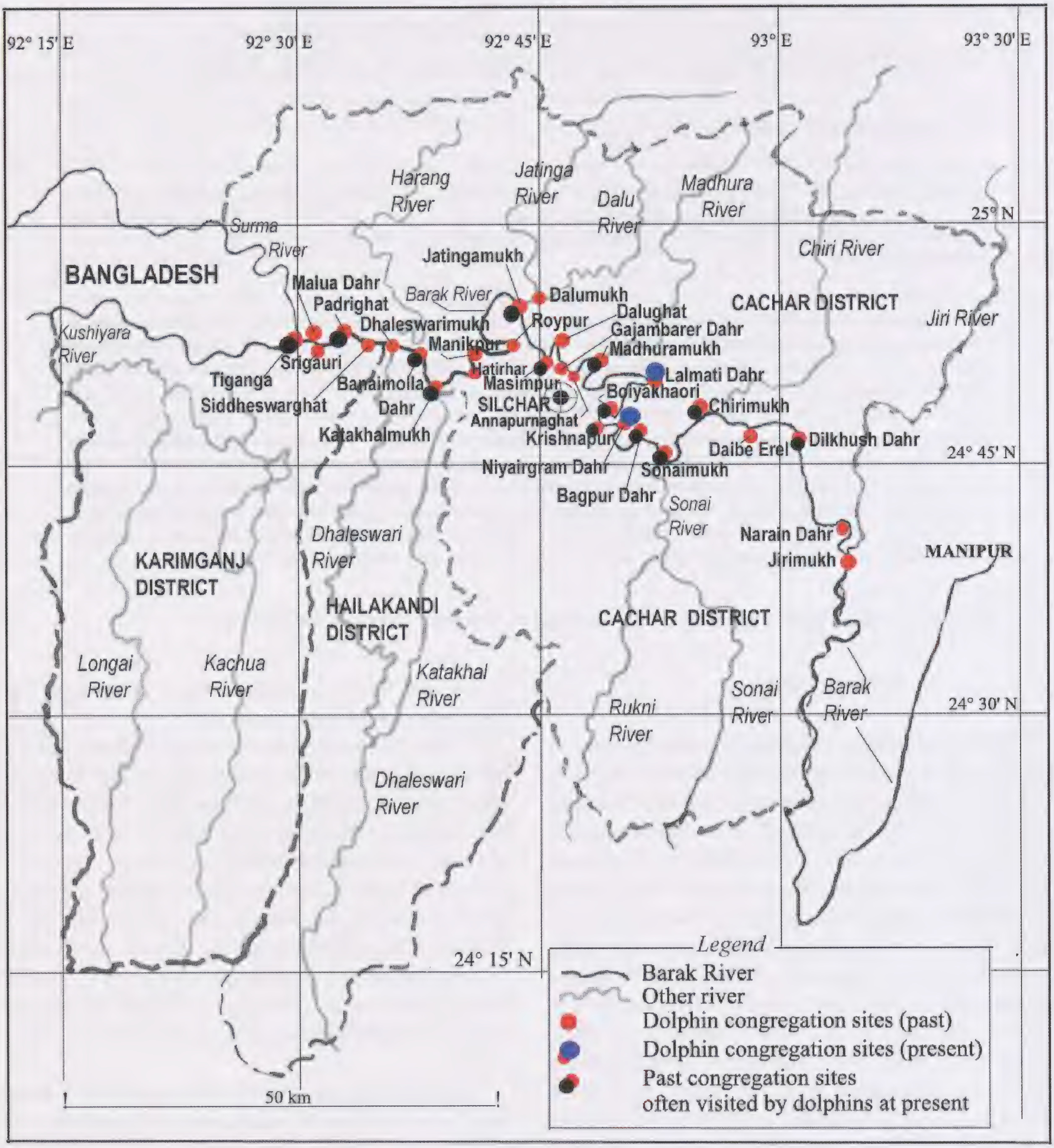

Fig. 1: Past and present distribution of the Ganges River Dolphin in the River Barak

after flowing for about 400 km in its hill course, starts its course in the plains at Fulertal, and after flowing for about 123 km entirely within India on a serpentine route reaches Tiganga in India. The important right-bank tributaries of the river include the Makru and the Jiri in Manipur, and the Chiri, Madhura, Jatinga, Dalu (a tributary of the Jatinga), and Larang in Barak Valley of Assam. The major left-bank tributaries are the Irang and the Tuivai (Tipai) in Manipur and Sonai, Rukni (a tributary of the Sonai), Ghagra, Katakhal, Dhaleswari, Singla, and Longai in Barak Valley. Banks and basin area of the Barak river system are thickly populated and this leads to enormous pressure on the land and water resources.

To locate dolphin localities in the Barak, information of such possible sites were first collected from Biswas (1995), Anon. (1999), and boatmen, fishermen, and other locals. With this information, 1:50,000 toposheet maps of Survey of India and satellite images from the internet were referred to know the accessibility to these sites. These sites were surveyed regularly throughout the study period (1999–2008).

Unlike the Brahmaputra and the Ganges, the River Barak, in the dry months, flows in a single channel of less than 200 m width, and thus 'rolling' of dolphins can be easily observed from a boat, shore, or bank. The surveys for the assessment of population were carried out during November to May, when the water levels were low and when dolphins were expected to remain in the main river. For assessment of population, two sets of surveys were carried out. The first set (7 surveys) covered the whole study area. The second set (6 surveys) covered the dolphin congregation area from Niyairgram to Lalmati Dahr (Fig. 1). The first set of surveys were carried out in 1999 (November), 2001 (December), 2003 (December), 2005 (December), 2006 (December), 2007 (December), and 2008 (April). The second set of surveys were carried out in 2000 (May), 2001 (April), 2004 (March), 2004 (December), 2006 (April), and 2007 (April). Surveys during and after 2001 were done following the method of Smith and Reeves (2000). It involved three observers sitting on a high platform in the extreme front of a country boat or a low-sound emitting motorboat moving at a slow speed (<9 km per hour), so that dolphins were not likely to be missed. Among the observers, the one in the middle acted as secondary observer and data recorder, while the others acted as primary observers. At every potential dolphin site, about 15 minutes were spent to look out for their presence. At known or observed dolphin congregation centres, more time was devoted. Measures to minimise both upward and downward bias in dolphin counts were adopted. In this respect, the size, colour, vicinity, and distance, and periodicity of rolling of the dolphins were considered. As determination of sex at the time of their surfacing from the water was extremely difficult, only categorisation of animals in terms of their age groups (adult, subadult, and calf) was done following Biswas and Boruah (2000). Accordingly, a specimen slate-grey and of a length of about 1.2 m or above was considered as adult; a specimen blackish in colour with a length of about 0.7 m or less was considered as calf; and a specimen of intermediate colour and length between 0.7–1.2 m was considered as subadult. The linear density (number of dolphins per km), within the dolphin congregation area (14 km), outside the congregation area (121 km), and the stretch of the River Barak surveyed (135 km), was calculated by dividing the number of dolphins encountered within the concerned area by 14, 121, and 135 – these being the length in kms of the river stretches surveyed respectively.

To collect information on occasional sighting of dolphins, their entanglement in fishing gear and their mortality, a semi-quantitative and qualitative questionnaire was prepared and people were interviewed. Information on reported mortality of dolphins was cross-checked with more than one source. Visits were also made on receiving specific information from the locals.

RESULTS

During the period of low water levels in the river (November–May), the dolphins were recorded to congregate at Lalmati Dahr (24° 49' N; 92° 51' E) and Niyairgram Dahr (24° 47' N; 92° 50' E), and forage there and in the 14 km stretch between these two sites. Almost every year, after a few pre-monsoon showers in March–May, newborn calves were recorded in this Lalmati Dahr–Niyairgram Dahr section. Calves were not seen in this stretch during January and February.

In a year's first flooding (May–June), individual dolphins and mother-calf pairs were sighted moving upstream. Dolphins coming from downstream (the Meghna, Kalni, Kushiyara, and elsewhere) were also seen to visit various parts of the Barak during this time. During the monsoon (mainly June–August), one or two dolphins were observed to visit and forage in the tributaries of the Barak: a subadult was found dead in the River Katakhal (at Lalachhera-Barnarpur near Lalaghat) in 1998; another adult drowned due to entanglement in fishing gear in the River Longai near Longai Ghat in 2005; a mother and calf were seen by the local people moving upstream in the swelling waters of the River Katakhal at Laishramkhun, Gaglachhera and Leihoupokpi (Madhabpur) near Lala in Hailakandi district in June, 2004. Dolphins still move out from the rivers to adjoining water bodies, if the situation permits. During the floods in 2007, three dolphins foraged for a whole day in an inundated paddy field of Roypur, a village 5 km to the north-west of Silchar town.

The surveys carried out to assess the dolphin population gave counts of 14, 12, 10, 9, 9, 8, and 8 in 1999, 2001, 2003, 2005, 2006, 2007, and 2008, respectively (Table 1). The population was made up of 59.32% adults, 31.36% subadults, and 9.32% calves. Among the dolphins encountered within the congregation area, 61.32%, 29.25%, and 9.43% were adults, subadults, and calves respectively. Among those encountered outside the congregation area, 41.66%, 50%, and 8.33% of the population were adults, subadults, and calves respectively.

During the first set of surveys, 82% of the population was encountered between Niyairgram Dahr and Lalmati Dahr. The others were found moving and foraging solitarily within a distance of 15 km from the congregation area. Out of a total of 118 sightings of dolphins during the surveys, 11 sightings were of calves. Of these 11 calves, 9 were observed in March–May and 2 in November–December.

During 1999 to 2004, there were three cases of mortalities in the Lalmati Dahr area: in February 1999, April 2000, and November 2000. Two of the dolphins were juveniles. The dolphins were reported to be killed after getting entangled in fishing gear. A fourth entanglement in 2005 resulted in the death of an adult in the Longai (a southern tributary of the Kushiyara) at Longai Ghat near Karimganj town.

A total of 29 mortalities of dolphins were recorded in the Barak river system. Double-boat operated nets caused 27.59%, single-boat operated nets 17.24%, gill nets 17.24%, hook and lines 17.24%. Opportunistic killing of dolphins that entered creeks and shallow areas constituted 6.9%. Others casualties were 3.45% by harpoon and spear, 3.45% by seine net, and 3.45% fishing traps. Accidental piercing of the forehead by the dorsal fin of the catfish *Sperata seenghala*, while being caught and handled by the dolphins accounted for 3.45% of the mortalities.

DISCUSSION

According to elderly locals and fishermen, the Lalmati Dahr–Niyairgram Dahr dolphins have inhabited this stretch for many generations; their presence and calving have also been observed since the last ten years. During the surveys covering the whole study area, 82% of the population was encountered between Niyairgram Dahr and Lalmati Dahr. Of the dolphins seen within Niyairgram Dahr and Lalmati Dahr, 41.50%, 8.49%, 0.94%, 4.7%, and 42.45% were encountered at Niyairgram Dahr, Uttar Krishnapur Dahr, Badrimukh, Bhagador, and Lalmati Dahr respectively. Uttar Krishnapur Dahr, Badrimukh, and Bhagador lie between Niyairgram Dahr and Lalmati Dahr. This shows that Niyairgram Dahr and Lalmati Dahr are the primary congregation sites at present for the dolphins of the River Barak.

Linear density was found to be 0.30 dolphins per km in 113.0 km part in Kalni-Kushiyara river (Smith *et al.* 2001), and 0.08 dolphins per km in the section of the River Kushiyara located between the Bangladesh-India border and the confluence of the River Korangi (Smith *et et al.* 1998). The density rose slightly on moving up the Barak (0.1 per km in 1999, 0.09 per km in 2001 (Table 1). But, in a span of ten years (1999–2008) during our study, the overall population and linear density of the dolphins in the Barak and within the congregation area decreased by at least 40% (Fig. 2). The adult population decreased till 2005, but has remained stable for three years after that. Although new-born calves were recorded in the Lalmati Dahr–Niyairgram Dahr section in March–May of each year, neither the population of adults nor of subadults were recorded to increase during the study period. Rather, a decline was seen – the population of adults reduced to 5 from 8, and subadults to 2 from 5. This indicates

Table 1: Population of the Ganges River Dolphin in the River Barak

Month & Year	Inside congregation area (i)					Outside congregation area (ii)						
	Adult	Subadult	Calf	Total	Linear density dolphin/km	Adult	Subadult	Calf	Total	Linear density dolphin/km	Total ((I) + (II))	Overall linear density: dolphins/km in Barak river
Nov. 1999	7	4	1	12	0.86	1	1	0	2	0.017	14	0.1
May 2000	4	2	2	8	0.57	-	-	-	-	-	-	-
Apr. 2001	6	4	2	12	0.86	-	-	-	-	-	-	-
Dec. 2001	7	5	0	12	0.86	0	0	0	0	0.00	12	0.09
Dec. 2003	5	2	0	7	0.50	1	2	0	3	0.025	10	0.074
Mar. 2004	5	1	2	8	0.57	-	-	-	-	-	-	-
Dec. 2004	6	2	0	8	0.57	-	-	-	-	-	-	-
Dec. 2005	4	2	0	6	0.49	1	2	0	3	0.025	9	0.067
Apr. 2006	4	2	1	7	0.50	-	-	-	-	-	-	-
Dec. 2006	5	2	0	7	0.50	0	1	1	2	0.017	9	0.067
Apr. 2007	3	1	1	5	0.36	-	-	-	-	-	-	-
Dec. 2007	5	2	0	7	0.50	1	0	0	1	0.008	8	0.06
Apr. 2008	4	2	1	7	0.50	1	0	0	1	0.008	8	0.06
Total	65	31	10	106	-	5	6	1	12	-	118	-

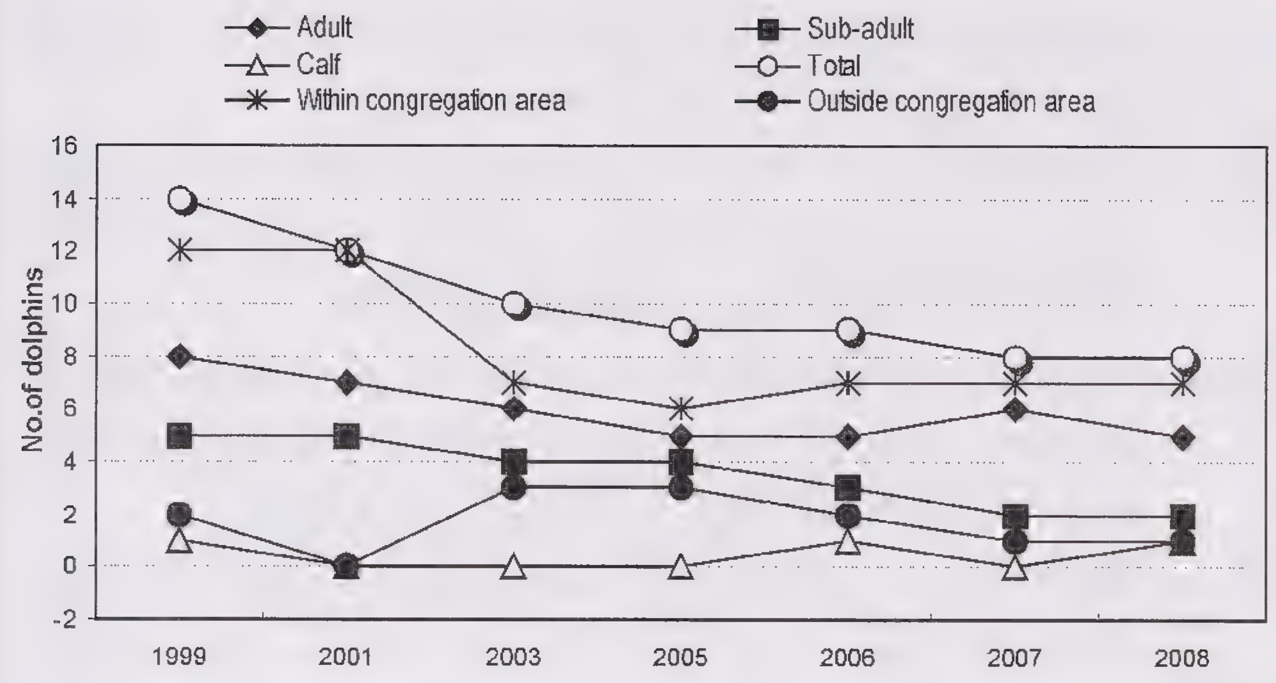

Fig. 2: Dolphin population in the River Barak (1999–2008)

a current zero survival rate of calves in the River Barak. According to Jefferson *et al.* (1993), calving of the Ganges River Dolphin apparently can occur at any time of the year, with peaks in December to January and March to May. In the River Barak, the peak was found to be during March–May, the months of pre-monsoon rains. The reason for not sighting calves in the congregation area in January–February could be that by January–February, the calves might have died or been killed.

In contrast to the Ganges, Brahmaputra, and Meghna, the width of the River Barak is much smaller (<200 m in dry season), and therefore, dolphins are more likely to get entangled in fishing gear and also more easily netted in the River Barak. In general, meaningful quantitative data on the magnitude of (river dolphin) catches, either deliberate or incidental, are unavailable and unlikely to become available in the absence of a well-organised, adequately funded, and incorruptible fishery/wildlife management system (Smith *et al.* 2008). However, riverside people in Barak Valley who saw entanglement, catching, killing, and selling of dolphin in their locality, were found to fairly well recollect such incidents because of the unusual and exceptional nature of the incidents. The data on mortality obtained from them indicate that calves suffered maximum casualties (38%), followed by subadults (34%) and adults (28%). Among the casualties of calves, 37% were due to entanglement in gill nets, 36% in single-boat operated fishing nets, 18% in double-boat operated drag nets and 9% in seine nets. Except for one or two cases of death that might have occurred due to drowning after entanglement in gill nets or others, almost all the other deaths were due to deliberate killing by fisherman and other locals. In some parts of the River Barak, from a little upstream of Katakhalmukh to the bifurcation point of the Barak in general, and sites near Banaimolla Dahr, Padri Ghat, Srigauri, and Malua Dahr (Fig. 1) in particular, some fishermen go for community hunting of dolphins, especially calves and subadults. They surround and chase the dolphins using nets, forcing them to enter a creek to kill them.

The consumption of dolphin meat by some locals, and the use of its oil as a fish attractant, as medicine for a variety of diseases (e.g., arthritis, rheumatism), aphrodisiac, and ointment for humans and livestock encourage the hunting of dolphins. The price of 100 ml of dolphin oil (not sold openly) in the Barak Valley in 2008 was more than Rs. 100. Apart from killing of dolphins during fishing as direct catch and by-catch, habitat degradation in the form of loss of *dahrs* (pools) as a result of change in river course and siltation of bed, depletion of prey fish, loss of foraging grounds due to the erection of embankments, dams, and sluice gates, and aquatic pollution pose threats to dolphins in the River Barak.

RECOMMENDATIONS

Since 1999, the district and state level authorities have been approached from time to time to adopt measures for the conservation of dolphins and their habitat in the River Barak. Some conservation measures have already been adopted, and these include:

1. Exemption of the dolphin congregation area from leasing out to public for fishery and earning of government revenue;

2. Clamping of Section 144, Cr.P.C. at Lalmati Dahr area to restrain any form of fishing there;

3. Submission of Feasibility Report of Dolphin Sanctuary by the DFO, Cachar, to the Chief Conservator of Forests, Assam;

4. Issue of order for demarcating the proposed area of Dolphin Sanctuary.

To make people aware and involve them in conservation, all forms of locally available media (audio, video, print) were explored. Doordarshan Kendra, Silchar, has produced documentaries, entitled 'Endangered dolphins of the Barak', in Bengali and in English. These documentaries, scripted by the present corresponding author, have already been telecast more than 10 times since the first telecast in 2000. Talks, campaigns, meetings, workshops, and nature camps have also been organised. These initiatives have probably helped arrest the decline in the dolphin population since 2007. However, unlawful fishing continues unabated in various parts of the River Barak, its tributaries and other water bodies throughout the Barak Valley and also at the dolphin congregation sites jeopardising, directly or indirectly, the life and security of the few surviving dolphins.

To conserve the dolphins of the Barak, the following measures are suggested:

1. Notification of Lalmati Dahr–Niyairgram Dahr section of the River Barak as Barak Dolphin Sanctuary. During

the interim period, prior to notification and proper functioning of the Dolphin Sanctuary, promulgation and strict enforcement of Section 144 Cr.P.C. to stop any form of fishing in the dolphin congregation sites, removal of any encumbrances in the dolphin foraging/congregation area, and keeping a 24-hour vigil on congregating dolphins and their movements at least during post-monsoon to pre-monsoon period, are required.

2. Monitoring, maintenance, and enhancement of the habitat at dolphin congregation sites, and establishment of similar conditions at nearby river meanders for habitat expansion and alternative congregation sites
3. Sensitisation of riverside people to act as local guardians of the dolphins of their localities. Panchayats may be involved in this aspect.
4. Engaging fishermen of Lalmati Dahr–Niyairgram Dahr section in conservation and eco-tourism, and/or providing them alternative livelihoods.
5. Inclusion of the safety and security of life and habitat of dolphin in all assessment, reassessment, planning, and execution of river development works.
6. Exploring the possibility of developing selected *anuwas* (oxbow lakes) of the River Barak for *ex situ* conservation, dolphin studies, and ecotourism.
7. Strict enforcement of fishery and wildlife protection acts and rules throughout the Barak sub-basin.

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PTERIDOPHYTIC DIVERSITY OF BAROT, MANDI DISTRICT, HIMACHAL PRADESH, INDIA

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This communication provides an inventory of the pteridophytes of Barot in the Uhl Valley of Mandi district, Himachal Pradesh, based on extensive field surveys carried out during 2010–2011. Ninety species of pteridophytes (85 ferns and 5 fern-allies) belonging to 31 genera and 14 families were recorded, which represents about 95% of the pteridophytic flora of Mandi district, and 35% of fern and fern-allies of Himachal Pradesh. Information on the species diversity, habitat, and current status of the taxa based on the survey are provided in this paper. Besides collecting voucher specimens of all the 90 species encountered for herbarium, live collections of 80 species of ferns and fern-allies were collected and introduced in the fernery of the institute for conservation and multiplication purposes, and most have been successfully established *ex-situ*. Strategies for bioprospection of selective species, and conservation of some rare threatened species are also discussed.

Key words: Diversity, pteridophytes, ferns, Barot, Mandi district, Himachal Pradesh

INTRODUCTION

The Himalayan region is one of the most varied and richest phytogeographical regions of India. The history of exploration of pteridophytes in the western Indian Himalaya goes back to the early 19th century, when John Forbes Royle, Nathaniel Wallich, and various other plant collectors initiated plant collection activities for the East India Company's herbarium, now known as the Central National Herbarium, Kolkata (CAL). Extensive field studies carried out by various workers in the recent past has revealed that the western Himalaya is one of the richest regions for pteridophytes in India (after east Indo-Himalaya and southern India), harbouring around 385 species (Fraser-Jenkins 2010) and representing nearly 40% of the pteridophytic flora of India.

Based on the collections of early British plant collectors, ferns of this region were mentioned in the British fern floras of India (Beddome 1883; Clarke 1880; Hope 1899–1904). Subsequently, significant contributions were made by Bir (1964, 1968); Dhir (1980); Dhir and Datta (1976, 1977a,b, 1979); Fraser-Jenkins (1992, 1997, 2008); Khullar (1994, 2000); Schelpe (1954); and Sharma and Khullar (2004). Recent comprehensive accounts of the pteridophytes of Kangra and Sirmaur districts of Himachal Pradesh (HP) have been published by Khullar *et al.* (2008, 2009).

Himachal Pradesh, a part of western Himalaya, is a land of deep valleys and lofty snow mountains with great altitudinal variations from 300 m in the foothills to high snow covered peaks of the greater Himalaya. Barot, in Mandi district of HP, is situated in the Uhl river valley, which is covered by thick forests of Cedar and Himalayan Oak. The hilly tract of Barot rises from Jhatingri to Tikkan, and into Barot *tehsil*. The thick forest cover is mainly composed of

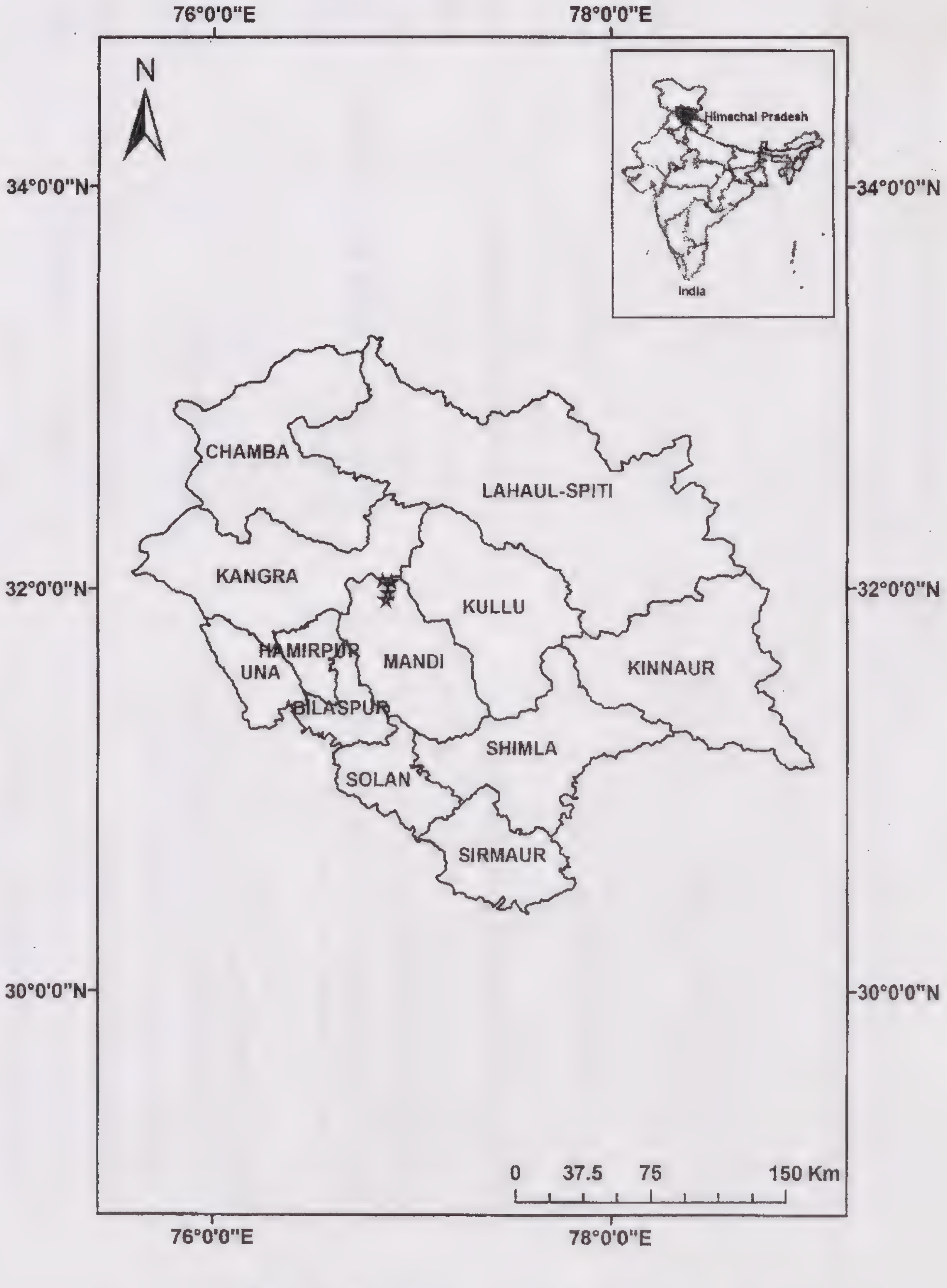

Fig. 1: Map showing study area

Table 1: Fern and fern-allies recorded during the survey of Barot area, Himachal Pradesh

Sl.No.	Family & Species Names	Collection Site	Occurrence	Altitude (m)	Herbarium Acc. No
	Family: **Selaginellaceae**				
1.	*Selaginella chrysocaulos* (Hook. & Grev.) Spring	Ghatasani to Jhatingri	Very common along roadside slopes. Also found growing along with moss *Thallus* on moist shady sites.	1,500–1,600	PLP-16311
2.	*Selaginella chrysorrhizos* Spring	Ghatasani to Jhatingri	Common on moist and shady slopes of hills and banks of streams.	1,500–1,600	PLP-16312
3.	*Selaginella subdiaphana* Spring	Ghatasani to Jhatingri	Very common in moist, shady parts of rocks with soil rich in humus.	1,600	PLP-16310
	Family: **Equisetaceae**				
4.	*Equisetum diffusum* D. Don	Ghatasani, Tikkan and Jhatingri	Common along waterfalls, streams and other wet places.	1,500–1,600	PLP-16322
5.	*Equisetum ramosissimum* Desf.	Ghatasani	Occasional. Along ravine banks.	750–1,500	PLP-16331
	Family: **Osmundaceae**				
6.	*Osmunda claytoniana* L. subsp. *vestita* (Wall. ex Milde) Á. Löve & D. Löve.	Near Jhatingri	Common in meadows or on the forest floor.	1,600–1,800	PLP-16343
7.	*Osmunda japonica* Thunb.	Tikkan to Barot	Rare. On moist, shaded rocks, walls, and mountain slopes.	1,600–1,800	PLP-16342
	Family: **Lygodiaceae**				
8.	*Lygodium flexuosum* (L.) Sw.	Tikkan	Uncommon. Climber on trees.	1,600–1,700	PLP-16339
9.	*Lygodium japonicum* (Thunb.) Sw.	Ghatasani to Jhatingri	Common. Usually occurs on foothills as scandent climber.	1,500–1,600	PLP-16384
	Family: **Polypodiaceae**				
10.	*Lepisorus mehrae* Fraser-Jenk.	Tikkan	Uncommon, epiphyte/lithophyte.	1,600–1,700	PLP-16340
11.	*Lepisorus nudus* (Hook.) Ching	Tikkan to Barot	Common, epiphyte/lithophyte.	1,800	PLP-16341
12.	*Lepisorus pseudonudus* Ching	Tikkan to Barot	Rare, epiphyte/lithophyte.	1,600–1,800	PLP-16344
13.	*Lepisorus sequipedalis* (J. Smith) Fraser-Jenkins	Ghatasani to Jhatingri	A common epiphyte/lithophyte.	1,500–1,600	PLP-16351
14.	*Microsorum membranaceum* (D. Don) Ching	Ghatasani to Jhatingri	Rare lithophyte, occurs on wet rocks along banks of streams; even as epiphyte on trees.	1,600	PLP-16385
15.	*Phymatopteris oxyloba* (Wall. ex Kunze) Pic. Serm.	Ghatasani to Jhatingri	Uncommon, epiphyte/lithophyte on humus-rich, shaded walls.	1,500–1,600	PLP-16355
16.	*Polypodiodes amoena* (Wall. ex Mett.) Ching	Jhatingri and Tikkan	Fairly common, epiphyte/lithophyte.	1,200–1,700	PLP-16386
17.	*Polypodiodes lachnopus* (Wall ex Hook.) Ching	Tikkan to Barot	Rare, epiphyte/lithophyte.	1,800	PLP-16315
18.	*Polypodiodes microrhizoma* (C.B. Clarke ex Baker) Ching	Tikkan to Barot	Occasional, epiphyte/lithophyte.	1,700–1,800	PLP-16387
19.	*Pyrrosia flocculosa* (D. Don) Ching	Ghatasani	Very common, epiphyte/lithophyte.	1,100–1,500	PLP-16347
20.	*Pyrrosia porosa* (C. Presl) Hovenkamp	Tikkan to Barot	Rare, epiphyte/lithophyte.	1,800	PLP-16388
	Family: **Dennstaedtiaceae**				
21.	*Dennstaedtia scabra* (Wall. ex Hook.) T. Moore	Jhatingri and Tikkan	Rare, on steep slopes near waterfalls and deep sheltered streams.	1,600–1,700	PLP-16336

Table 1: Fern and fern-allies recorded during the survey of Barot area, Himachal Pradesh (*contd.*)

Sl.No.	Family & Species Names	Collection Site	Occurrence	Altitude (m)	Herbarium Acc. No
22.	*Hypolepis polypodioides* (Blume) Hook.	Jhatingri and Tikkan	Fairly common, seen in patches in exposed areas of streams.	1,500–1,700	PLP-16303
	Family: **Pteridaceae**				
23.	*Adiantum capillus-veneris* L.	Lower to upper Barot	Very common, on walls, in wet places, rocks, water courses, canals, and slopes.	1,500–1,800	PLP-16383
24.	*Adiantum edgeworthii* Hook.	Tikkan to Barot	Localised, on humus-rich forest slopes.	1,800	PLP-16348
25.	*Adiantum incisum* Forssk.	Ghatasani	Very common, along roadsides, in rock-crevices, on slopes, walls.	1,500	PLP-16347
26.	*Adiantum philippense* L.	Ghatasani to Jhatingri	Fairly common, along streams, roadsides, in humid and shaded areas.	1,600	PLP-16350
27.	*Adiantum venustum* D. Don	Barot	Common, on forest floor and along forest edges.	1,800	PLP-16352
28.	*Adiantum venustum* D. Don subsp. *tibeticum* (Ching & Y.X. Linn.) Khullar	Barot	Uncommon, inhabits humus-rich forest floor and forest slopes at high altitudes.	1,800	PLP-16353
29.	*Aleuritopteris albomarginata* (C.B. Clarke) Ching	Ghatasani, Tikkan, and Jhatingri	Common, along roadside slopes, cultivated fields, grasslands, and forest floor.	1,600–1,800	PLP-16363
30	*Aleuritopteris anceps* (Blanf.) Panigrahi	Jhatingri, Tikkan	Rare, on forest slopes and rock surfaces.	1,600–1,800	PLP-16367
31.	*Aleuritopteris bicolor* (Roxb.) Fraser-Jenk.	Ghatasani, Tikkan and Jhatingri	Very common, on slopes, along roadsides, on walls, in rock-crevices.	1,500–1,600	PLP-16363
32.	*Aleuritopteris formosana* (Hayata) Tagawa	Tikkan to Barot	Frequent, on rocks in forest.	1,800	PLP-16382
33.	*Aleuritopteris rufa* (D. Don) Ching	Jhatingri and Tikkan	Rare, on wet rocks and hill slopes.	1,500–1,800	PLP-16345
34.	*Coniogramme intermedia* var. *intermedia* Hieronymus	Barot to Lohardi	Rare, on moist slopes of hills, near roadsides.	1,800	PLP-16375
35.	*Coniogramme pubescens* Hieronymus	Barot to Lohardi	Common, on slopes of hills in moist, shady areas.	1,800	PLP-16370
36.	*Coniogramme serrulata* (Blume) Fée	Barot to Lohardi	Common, on slopes of hills in moist, shady areas.	1,800	PLP-16364
37.	*Gymnopteris vestita* (Wall.) Underw.	Tikkan to Barot	Rare, on moist or wet rocks in exposed areas along roadsides.	1,800	PLP-16382
38.	*Onychium cryptogrammoides* Christ	Ghatasani, Tikkan and Jhatingri	Fairly common, on humus-rich forest floor, and open areas.	1,500–1,600	PLP-16348
39.	*Onychium japonicum* (Thunb.) Kunze	Tikkan to Barot	Fairly common, on humus-rich forest floor.	1,800	PLP-16349
40.	*Pellaea nitidula* (Wall. ex Hook.) Baker	Tikkan to Barot	Rare, inhabits moist walls/slopes, rock-crevices.	1,800	PLP-16359
41.	*Pteris aspericaulis* Wall. ex J. Agardh	Ghatasani, Tikkan, and Jhatingri	Very common, at forest edges.	1,500–1,600	PLP-16358
42.	*Pteris cretica* L.	Ghatasani, Tikkan, and Jhatingri	Very common, on humus-rich forest floor, in open or shaded localities.	1,500–1,600	PLP-16364
43.	*Pteris terminalis* Wall. ex J. Agardh	Tikkan to Barot	Uncommon, in highly humid areas, shaded damp places in the forest/streams.	1,800	PLP-16379
44.	*Pteris vittata* L. ssp. *emodi* Fraser-Jenk.	Ghatasani to Jhatingri	Common, on open roadsides, on walls.	1,600	PLP-16318
45.	*Pteris wallichiana* J. Agardh	Ghatasani to Jhatingri	Fairly common, in forest, dry streambeds, moist spots.	1,600	PLP-16357
	Family: **Aspleniaceae**				
46.	*Asplenium dalhousiae* Hook.	Ghatasani to Jhatingri	Very common, inhabits moist walls/slopes or rock-crevices.	1,600	PLP-16309

Table 1: Fern and fern-allies recorded during the survey of Barot area, Himachal Pradesh (*contd.*)

Sl.No.	Family & Species Names	Collection Site	Occurrence	Altitude (m)	Herbarium Acc. No
47.	*Asplenium laciniatum* D. Don	Barot to Lohardi	Uncommon, on moist-shaded rocks, forest edges, even at base of tree trunks.	1,800	PLP-16354
48.	*Asplenium trichomanes* L.	Barot to Lohardi	Uncommon, inhabits rock-crevices, in shade or moist forest slopes.	1,800	PLP-16356
	Family: **Thelypteridaceae**				
49.	*Thelypteris arida* (D. Don) C.V. Morton	Ghatasani	Very common, along river banks, watercourses, and moist ditches.	1,500	PLP-16360
50.	*Thelypteris auriculata* (J. Sm.) K. Iwats.	Ghatasani to Jhatingri	Very common, along river banks, watercourses, and moist ditches.	1,600	PLP-16365
51.	*Thelypteris cana* (Baker) Ching	Jhatingri	Very common, along streams.	1,700	PLP-16366
52.	*Thelypteris dentata* (Forssk.) E.P. St. John	Ghatasani	Very common, along watercourses and moist ditches.	1,500	PLP-16389
53.	*Thelypteris erubescens* (Wall. ex Hook.) Ching	Jhatingri	Common, along waterfalls, roadsides, near ravines.	1,600	PLP-16368
54.	*Thelypteris prolifera* (Retz.) C.F. Reed	Ghatasani	Very common, low altitude fern, climber, found in the plains along river banks/watercourses.	1,600	PLP-16369
55.	*Thelypteris pyrrhorhachis* Kunze	Tikkan	Common, along streams, watercourses, in humus-rich places.	1,800	PLP-16374
56.	*Thelypteris papilio* (C. Hope) K. Iwats.	Jhatingri	Rare, inhabits wet places along forest streamlets, and along roadsides.	1,600	PLP-16378
57.	*Thelypteris tylodes* (Kunze) Ching	Ghatasani to Jhatingri	Fairly common, near streams.	1,600	PLP-16306
	Family: **Woodsiaceae**				
58.	*Athyrium anisopterum* Christ	Tikkan	Rare fern, fronds hang and grow on moist/dripping rocks.	1,800	PLP-16362
59.	*Athyrium atkinsonii* Beddome	Barot	Fairly common, at high altitude.	>1,800	PLP-16376
60.	*Athyrium fimbriatum* (Hook.) Hook. ex T. Moore	Tikkan	Uncommon, damp forest, along waterfalls, in shade.	1,800	PLP-16337
61.	*Athyrium micropterum* Fraser-Jenk.	Barot	Rare, on wet, moss-covered rocks, damp shaded cliffs, even in open river gorges and meadows.	1,800	PLP-16357
62.	*Athyrium pectinatum* (Wall. ex Mett.) T. Moore	Ghatasani to Jhatingri	Very common, epiphyte/lithophyte, also in terrestrial habitats at open forest edges.	1,500–1,600	PLP-16314
63.	*Athyrium schimperi* Moug. ex Fée	Ghatasani to Jhatingri	Fairly common, on humus-rich forest floor, along shaded . forest edges.	1,500–1,600	PLP-16307
64.	*Athyrium setiferum* C. Chr.	Barot	Uncommon, in shaded areas along streamlets.	1,800	PLP-16308
65.	*Athyrium strigillosum* (E.J. Lowe) Salmon	Ghatasani to Jhatingri	Fairly common, in wet places, along banks and beds of well-shaded ravines.	1,500–1,600	PLP-16338
66.	*Deparia allantodioides* (Bedd.) M. Kato	Jhatingri to Tikkan	Rare, inhabits humus-rich forest floor along water channels.	1,600–1,800	PLP-16373
67.	*Deparia petersenii* (Kunze) M. Kato subsp. *petersenii* Kato	Ghatasani	Common, on roadside slopes.	1,400–1,600	PLP-16301
68.	*Deparia boryana* (Willd.) M. Kato	Barot	Rare, on forest floor.	>1,800	PLP-16304
69.	*Diplazium maximum* (D. Don) C. Chr.	Ghatasani to Jhatingri	Fairly common, along streamlets, wherever water is in plenty, also in forest.	1,500–1,600	PLP-16390

Table 1: Fern and fern-allies recorded during the survey of Barot area, Himachal Pradesh (*contd.*)

Sl.No.	Family & Species Names	Collection Site	Occurrence	Altitude (m)	Herbarium Acc. No
70.	*Hypodematium crenatum* subsp. *crenatum* (Forssk.) Kuhn & Decken	Jhatingri	Uncommon, in exposed conditions in rock-crevices, on slopes.	1,600	PLP-16372
	Family: **Dryopteridaceae**				
71.	*Cyrtomium anomophyllum* (Zenker) Fraser-Jenk.	Barot to Lohardi	Common, in damp shaded localities along roadsides, waterfalls, and streams.	1,800	PLP-16391
72.	*Cyrtomium caryotideum* (Wall. ex Hook. & Grev.) C. Presl	Barot	Rare, in damp shaded localities along roadsides, and along waterfalls/streams.	1,800	PLP-16377
73.	*Dryopteris caroli-hopei* Fraser-Jenk.	Ghatasani and Jhatingri	Fairly common, on moist, humus-rich forest floor, and along roadsides.	1,500–1,600	PLP-16327
74.	*Dryopteris cochleata* (Buch.-Ham. *ex* D. Don) C. Chr.	Jhatingri	Rare, on forest floor.	1,600	PLP-16332
75.	*Dryopteris juxtaposita* Christ	Tikkan	Uncommon/Rare, mainly grows in rocky places.	1,700	PLP-16333
76.	*Dryopteris nigropaleacea* (Fraser-Jenk.) Fraser-Jenk.	Jhatingri-Tikkan	Very common, in humus-rich areas of forest floor.	1,600	PLP-16335
77.	*Dryopteris ramosa* (C. Hope) C. Chr.	Barot	Rare, inhabits forest floor amongst rocks.	1,800	PLP-16392
78.	*Dryopteris redactopinnata* S.K. Basu & Panigrahi	Barot to Lohardi	Rare, on forest floor.	1,800	PLP-16393
79.	*Dryopteris wallichiana* (Spreng.) Hylander	Barot	Rare, on forest floor.	1,800	PLP-16380
80.	*Polystichum discretum* (D. Don) J. Smith	Jhatingri	Fairly common, inhabits humus-rich forest floor, sometimes at edges of open places.	1,600	PLP-16329
81.	*Polystichum lentum* (D. Don) T. Moore	Ghatasani to Jhatingri	Very common, on dark moist slopes of rocks in shade.	1,600	PLP-16320
82.	*Polystichum mehrae* Fraser-Jenk. & Khullar	Barot	Rare, in rock-crevices.	1,800	PLP-16394
83.	*Polystichum piceopaleaceum* Tagawa	Ghatasani to Jhatingri	Common, on forest floor, in moist places at forest edge.	1,600	PLP-16330
84.	*Polystichum squarrosum* (D. Don) Fée	Ghatasani	Very common, on forest floor, along forest edges.	1,600	PLP-16395
85.	*Polystichum yunnanense* Christ	Tikkan	Common, on forest floor, moist places along streams.	1,800	PLP-16305
86.	*Tectaria coadunata* (Wall. ex Hook. & Grev.) C. Chr.	Jhatingri	Rare, amongst rocks and in rock-crevices near water channels.	1,600	PLP-16321
	Family: **Oleandraceae**				
87.	*Oleandra wallichii* (Hooker) C. Presl	Jhatingri	Rare, on shaded wet rock surfaces, tree trunks in forest.	1,600–1,700	PLP-16381
	Family: **Davalliaceae**				
88.	*Araiostegia delavayi* (Bedd. ex C.B. Clarke & Baker) Ching	Tikkan and Barot	Rare, epiphyte.	1,700–1,800	PLP-16396
89.	*Araiostegia pulchra* (D. Don) Copel	Jhatingri and Tikkan	Common, epiphyte on tree trunks and branches, moist shaded walls/rocks.	1,600	PLP-16302
	Family: **Blechnaceae**				
90.	*Woodwardia unigemmata* (Makino) Nakai	Barot to Lohardi	Fairly common, in wet localities, along roadsides, and in forest.	1,800	PLP-16325

Himalayan Cedar *Cedrus deodara* and Banj or Himalayan Oak *Quercus leucotrichophora*. The natural and perennial deep gorges, along with Uhl river, provide favourable conditions for the growth of pteridophytes. Barot area, which harbours a good number of pteridophytes, is largely unexplored from the pteridophytic point of view, though sketchy information is available (Beddome 1865–70, 1883; Clarke 1880; Hope 1899–1904). In the recent past, a few species of pteridophytes from Mandi district have been reported (Chandra 2000; Khullar 1994, 2000). However, there has been no comprehensive account on the fern flora of the Mandi district in general and the Barot area in particular. Hence, we carried out this work to document the fern and fern-allies (pteridophytes) diversity of the Barot area, which covered an area ranging from 30° 22"–33° 12" N and 75° 47"–79° 40" E, with altitudes ranging between 1,500 and 1,820 m (Fig. 1).

MATERIAL AND METHODS

Extensive field visits were made to different sites in Barot during 2010–2011 to cover the study area thoroughly. Voucher specimens of each species were collected along with field notes for identification and documentation. All the specimens collected were identified and processed following standard herbarium techniques (Jain and Rao 1977). Later, all the specimens were deposited in the herbarium of the CSIR-Institute of Himalayan Bioresource Technology, Palampur (PLP).

In this paper, the recorded taxa are categorised into two major groups, namely ferns and fern-allies. In each group, enumeration is made family-wise as per the classification of Fraser-Jenkins (2008, 2009). The genera within the family and species within each genus are arranged in alphabetical order, giving details of localities, collection number, and habitat.

RESULTS

Ninety species of pteridophytes (85 ferns and 5 fern-allies) belonging to 31 genera and 14 families were recorded (Table 1).

DISCUSSION

Our explorations revealed that the Barot area is rich in fern diversity, harbouring *c.* 95% of the pteridophytic flora of Mandi district, and 35% of Himachal Pradesh. Ninety species were recorded (85 ferns and 5 fern allies), belonging to 31 genera and 14 families. Of these, 25 species are lithophytic and epiphytic in nature, growing luxuriantly on the trunks of cedar, rhododendron, and oak, and on rocky slopes. The rest (65 species) are terrestrial, mostly found growing in moist, shady slopes in the forests. Two straggling ferns, *Lygodium flexuosum* and *L. japonicum* were also recorded. The dominant families are Pteridaceae (23 species), Dryopteridaceae (16 species), Woodsiaceae (13 species), Polypodiaceae (11 species), Thelypteridaceae (9 species), and Aspleniaceae (3 species). Equisetaceae, Osmundaceae, Lygodiaceae, Dennstaedtiaceae, and Davalliaceae are represented by two species each. Oleandraceae and Blechnaceae are represented by a single species each. *Coniogramme*, *Onychium*, *Polystichum*, *Pteris*, and *Thelypteris* were common and widespread, while *Osmunda japonica*, *Phymatopteris oxyloba*, *Oleandra wallichii*, *Pyrrosia porosa*, *Pellaea nitidula*, and *Gymnopteris vestita* were rare or uncommon ferns in the area.

Ferns are well-known for their ornamental value and find a place in gardens, conservatories, and ferneries. There are also a number of species with therapeutic values. Genera like *Adiantum*, *Aleuritopteris*, *Asplenium*, *Diplazium*, *Equisetum*, *Lepisorus*, *Oleandra*, *Onychium*, *Osmunda*, and *Polystichum* that occur in the Barot region are also known for their food and medicinal value (Singh 2003). *Diplazium maximum* is used by the locals as a seasonal vegetable and is sold in the local markets.

Ferns are also important from the ecological point of view. Keeping in view their economic and ecological importance, propagatory material of 80 rare and uncommon ferns was collected and planted in the fernery of the institute for conservation, cultivation, and for other studies. These species include *Diplazium maximum*, *Equisetum ramosissimum*, *Onychium contiguum*, *Oleandra wallichii*, *Osmunda claytoniana*, *O. japonica*, *Phymatopteris oxyloba*, *Pyrrosia porosa*, *Pellaea nitidula*, and *Gymnopteris vestita*, which are now established in the fernery, and available for biochemical and other investigations.

In Barot, certain localities harbour high populations of *Cyrtomium*, *Coniogramme*, and *Osmunda* species, and these should be protected as *in-situ* sites for the conservation of these species. There is also a need for the cultivation/propagation of some pteridophytes by applying modern tools for potential sustainable use. Considering the rich fern diversity, there is a need for more field explorations of pteridophytes in and around Barot area to look for rare and new taxa, and also to prepare a conservation plan for these and other fern species.

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TERRITORIALITY IN KERALA LAUGHINGTHRUSH *STROPHOCINCLA FAIRBANKI MERIDIONALIS*

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The Kerala Laughingthrush *Strophocincla fairbanki* is a Near Threatened, endemic species of the Western Ghats of southern India, south of the Palakkad Gap (=Palghat Gap). Within its restricted range, it has two subspecies – the more widespread nominate race found in the high ranges north of the Shencottah Gap; and *meridionalis*, occurring south of the Gap. A study on territoriality was carried out on the latter at four study sites, namely Pandipath, Pandimotta, Kodayar, and Mahendragiri, in the Agasthyamalai hills from January 2011 to March 2011 after a pilot study in December 2010. Territory size of 30 pairs was estimated by following them and marking their locations using a GPS unit. The territories were found only in shola forests above 1,200 m above msl. Territories were not recorded in tea plantations, grasslands, scrub dominated rocky areas, bare rocky areas, forest patches adjoining reservoirs, and in large swathes of *Ochlandra*. The average territory size was estimated to be about 2 ha. No overlap of territories was observed and the territories were separated by an average distance of 66.04 m. Pairs were formed and territories defended only in the breeding season. Habitat loss and deterioration were identified as serious threats to the subspecies.

Key words: Kerala Laughingthrush, *Strophocincla fairbanki*, endemic, territory, Western Ghats, *Ochlandra*

INTRODUCTION

The Kerala Laughingthrush *Strophocincla fairbanki* (Blanford 1869) and Black-chinned Laughingthrush *Strophocincla cachinnans* are two species of montane laughingthrushes found in the Western Ghats, which are endemic to the high altitude habitats of the region above *c.* 1,200 m, namely subtropical montane forests known locally as sholas (Rasmussen and Anderton 2005; Sashikumar *et al.* 2011). The Black-chinned Laughingthrush is distributed in the sholas north of the Palakkad Gap (=Palghat Gap), while the Kerala Laughingthrush is restricted south of the Palakkad Gap.

The Kerala Laughingthrush has two subspecies, of which *S.f. meridionalis* (Blanford's or Travancore Laughingthrush) has a disjunct and restricted distribution confined to the Agasthyamalai (Ashambu) hills (Sashikumar *et al.* 2011). It is separated from the more widely distributed *S.f. fairbanki* by the Shencottah/Achenkovil Gap, a 7.5 km gap at 9° N. The present taxonomic status of these two allopatric forms as subspecies is in contention (Rasmussen and Anderton 2005), and they have been proposed for full species status (Praveen and Nameer 2011) subject to further molecular and acoustic (vocalisation) studies. Work in the 'sky-islands' of the Western Ghats have found that some subspecies that showed morphological differences also had a genetic distance higher than the acceptable limits for a species (Robin *et al.* 2010), and subsequently, these subspecies were re-evaluated by Birdlife International and their IUCN Red List status uplisted.

Despite being Near Threatened (BirdLife International 2010), the Kerala Laughingthrush, and especially the population of *S.f. meridionalis*, has not received much scientific attention and little is known about its ecology. *Strophocincla* spp., in general, are known to occur in parties of about a dozen individuals (Ali and Ripley 1987; del Hoyo *et al.* 2007); but their flock composition during the breeding season and the size of their breeding territories were not known. However, our pilot surveys in December 2010 revealed that breeding birds occurred in pairs during the breeding season, and collected nesting material and defended territories aggressively by calling and patrolling.

Strophocincla spp. are known to have an association with understorey plants of *Rubus* spp. (Ali and Ripley 1987) of the Rosaceae family, but the influence of other plant species on its distribution and habits is not known. *S.f. meridionalis* was believed to preferentially inhabit *Ochlandra travancorica* aggregations (Ali 1969), but recent observations suggest that *Ochlandra* dominated habitats may have a negative effect on its populations (Praveen *et al.* 2011; Sashikumar *et al.* 2011). *Ochlandra* (reed bamboo), locally known as Eeta, is represented by nine species in the Western Ghats (Sashidharan 2007). They are light-demanding species belonging to the Poaceae family and occur in places where there are gaps in the canopy (Adriel 1975), quickly colonising high-altitude forests that are lost to clear felling or forest fires. While other evergreen species and their saplings are damaged by fire, *Ochlandra* overcomes the effect of fire with its underground rhizomes and the forest evolves into *Ochlandra* brakes (Giriraj

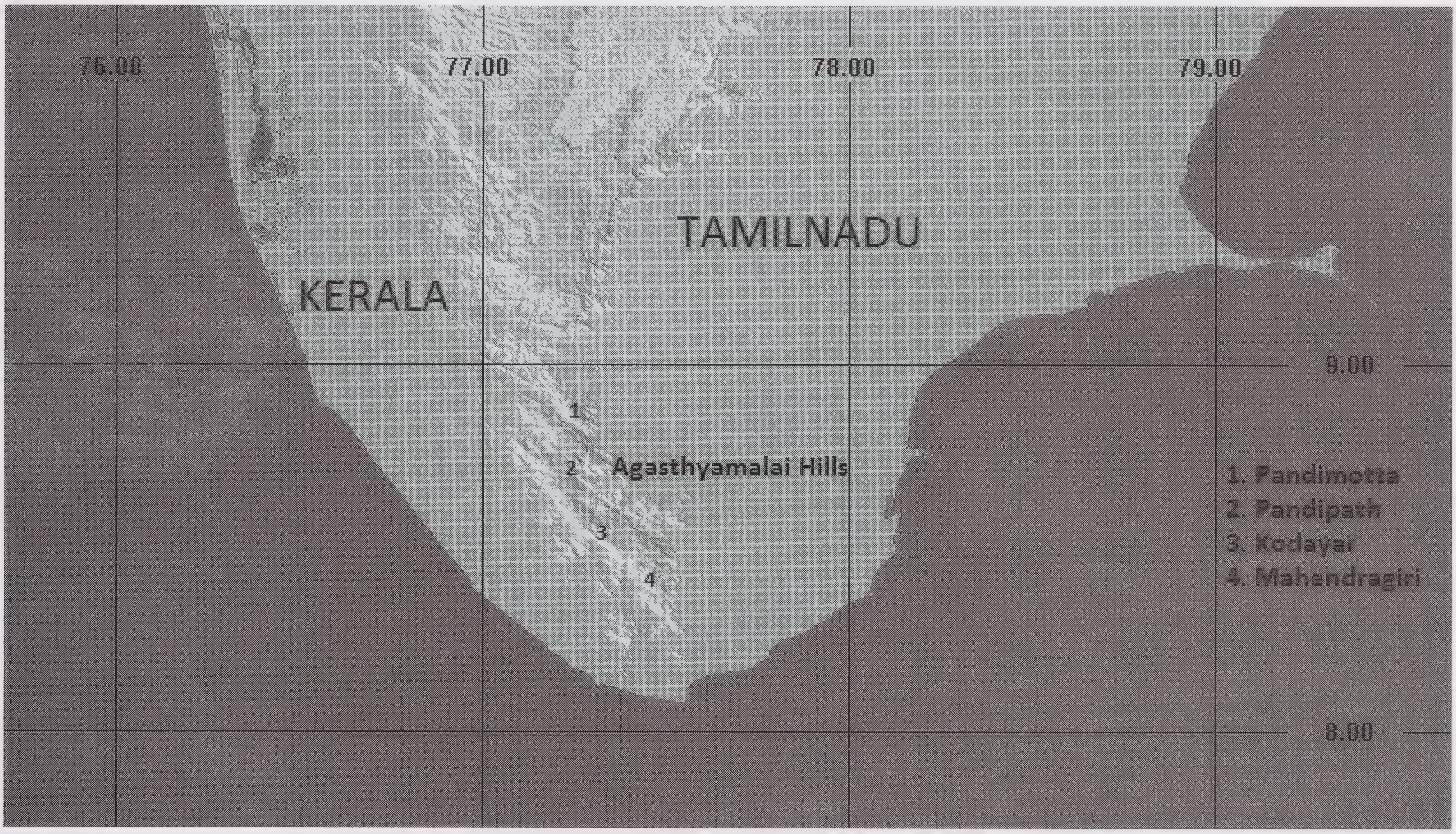

Fig. 1: Agasthyamalai (Ashambu) Hills of southern Western Ghats with samples sites

et al. 2008; Mohanan and Henry 1994). *Ochlandra* brakes are one of the major habitats in Agasthyamalai hills, with *Ochlandra travancorica* var. *hirsuta*, the largest species of *Ochlandra* in the Western Ghats, being dominant (Sashidharan 2007). Though all the *Ochlandra* species that occur in the Agasthyamalai hills are indigenous, it is unclear how such large stretches of *Ochlandra* dominated hilltops evolved in the region. Local enquiries indicate that this trend is rather recent, and is probably a result of anthropogenic disturbances during the last 50 years.

Climate change models have predicted a most-likely reduction in the area of montane habitats in the southern Western Ghats by 3.1% by 2020 and 7.3% by 2050 (Sukumar *et al.* 1995). It has been predicted that extinction risk due to climate change is higher for species with restricted elevation range and small Extent of Occurrence (EOO) (Sekercioglu *et al.* 2008) – both premises true for this subspecies of Laughingthrush. Responses to climate change on endemic birds of Western Ghats are largely unstudied, and *Strophocincla* spp. with their very restricted range are candidates for potential extinction in the future.

STUDY AREA

The Agasthyamalai (Ashambu) hills lie at the southern end of the Western Ghats along the western coast of peninsular India with its crest-line forming the boundary of Kerala and Tamil Nadu (Fig. 1). The hills fall in the districts of Kollam and Thiruvananthapuram in Kerala, and Tirunelveli and Kanyakumari in Tamil Nadu. The highest peak in this range is Agasthyarkoodam (1,868 m above msl). These hills receive up to 2,000 mm rainfall annually from both the south-west and north-east monsoons (Sashidharan 2012). The topography is rugged with many perennial hill streams originating in the tropical rain forests on the upper slopes, which merge to form several important rivers. The Agasthyamalai hills have Tropical Wet Evergreen Forest in the mid-elevation zone (700–1,400 m) and shola-grassland complex above 1,400 m (Champion and Seth 1968). The forests fall in the Kalakkad-Mundanthurai Tiger Reserve (KMTR) and Kanyakumari Wildlife Sanctuary (WLS) of Tamil Nadu, and Neyyar WLS, Peppara WLS, Shendurney WLS, and Kulathupuzha Reserve Forest of Kerala. The entire region has been designated as Agasthyamalai Biosphere Reserve (ABR), with 1,828 sq. km in Kerala and 1,672 sq. km in Tamil Nadu, for the protection of its unique flora and fauna (Tamil Nadu Forest Department 2007).

METHODOLOGY

Site Selection

Literature indicates that *S. f. meridionalis* does not occur

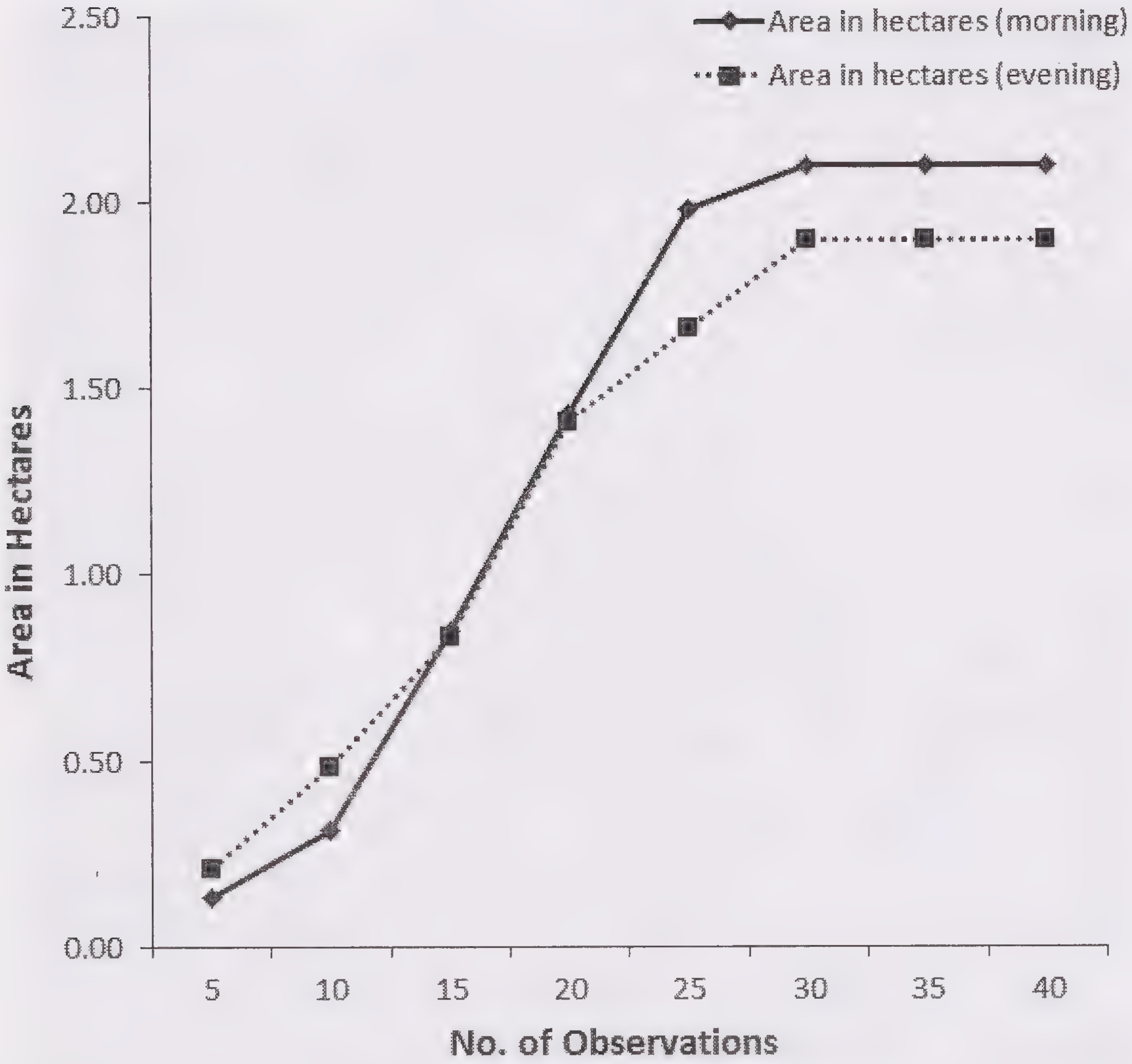

Fig. 2: Observation-area curve for a pair of *Strophocincla fairbanki meridionalis*

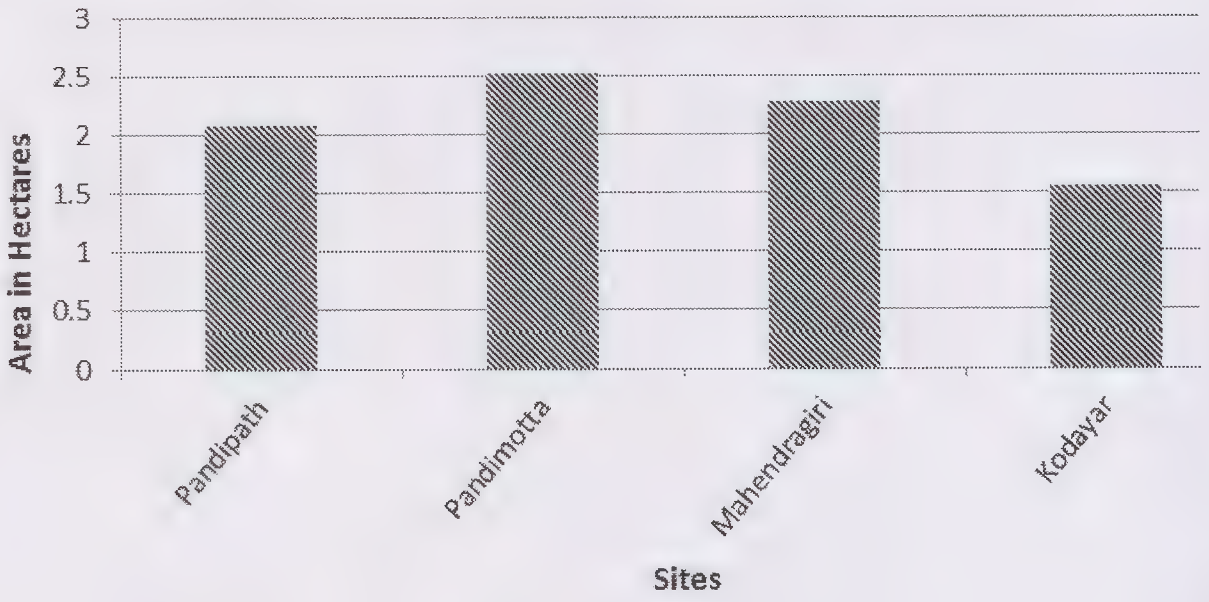

Fig. 3: Average maximum territory-size of *S.f. meridionalis* across the study sites

below an altitude of 1,200 m (Ali and Ripley 1987; Rasmussen and Anderton 2005; Sashikumar *et al.* 2011), and pilot studies carried out on the species (as part of a survey on the birds of high-altitude habitats of the region – Praveen *et al.* 2011) also revealed that the subspecies *S.f. meridionalis* does not frequent grasslands and rocky areas for breeding. Hence, based on altitudinal and habitat preferences of this subspecies, the focus of studies on territory were largely confined to suitable habitats in the high altitude regions of this range above the demarcating contours of 1,200 m, 1,400 m, and 1,600 m, as discussed further on.

In December 2010, the entire crest line from Pandipath (8° 40' N; 77° 11' E) in Peppara WLS till Varayattumudi (8° 34' N; 77° 16' E) in the border of Neyyar WLS and KMTR was walked by a 10-member team to survey *S.f. meridionalis*. This was followed with another survey in select areas to understand the ecology of the subspecies and assess the suitability of different survey techniques to detect it. Based on this survey and GIS information, four areas with contiguous stretches of high-altitude zones with altitudes over 1,200 m were identified. Four sites (Table 1) were selected within these four areas for intensive studies from January 2011 to March 2011, one of the main considerations being easy accessibility to enable repeated visits.

Thirty pairs, which could be followed on foot in contiguous habitat, were selected for the study from the four sites. As each pair showed fidelity towards a perch or its immediate surroundings in its territory, from where they called at dawn, individual identification of pairs was apparently possible. Apart from the four sites and 30 pairs observed, random surveys were carried out in other high-altitudinal regions of the hills to record the taxon and check if the sightings obtained from these sites adhered to the known preferred altitude and vegetation type of *S.f. meridionalis*.

Estimation of Territory Size

Estimation of territory size was based on 'maximum territory-size' (Odum and Kuenzler 1955), adapted from the method of 'Minimum Convex Polygon' (Mohr 1947), which is still in use for effectively estimating breeding territories of

Table 1: Details of the sampling sites

Site	Forest Zone	Coordinates	Altitude Range	Habitat
Pandimotta	Shendurney WLS, Kerala	8° 49' N 77° 13' E	1,200–1,755 m	Tropical Wet Evergreen Forests, sholas, montane grasslands with large congregations of *Ochlandra*.
Pandipath	Peppara WLS, Kerala	8° 40' N 77° 11' E	1,300–1,585 m	Tropical Wet Evergreen Forests, sholas, montane grasslands with some *Ochlandra* patches.
Kodayar	KMTR, Tamil Nadu	8° 31' N 77° 21' E	1,300–1,550 m	Tropical Wet Evergreen Forests, sholas, montane grasslands, some *Ochlandra* patches, tea plantations.
Mahendragiri	Kanyakumari WLS, Tamil Nadu	8° 22' N 77° 29' E	1,350–1,600 m	Tropical Wet Evergreen Forests, sholas, montane grasslands.

birds (Collister and Wilson 2007). Instead of carrying maps to the field and marking locations of the pairs on the maps, as has been practised, latitude-longitude readings of the locations were taken using a GPS to estimate territory size. The selected pairs were followed during their peak activity period, inferred from the pilot surveys as early morning (06:30–09:45 hrs) and evening (15:00–18:15 hrs). GPS readings were taken at five-minute intervals. To ensure that the pairs were followed for sufficient time to arrive at their maximum territory-sizes, 'observation-area' curves were used (Dudley and Saab 2007; Odum and Kuenzler 1955). After every 5 GPS points, the outermost points were connected to form a polygon and its area calculated. As the number of observations (GPS points) increased, the area increased to a point where continued observation resulted in no observed increase in area. A total of 80 GPS points (40 in the morning and 40 in the evening) were obtained per pair to estimate territory size. To calculate the maximum territory-size of a pair, the extreme outermost points of the separate polygons obtained from observations in the mornings and evenings were joined to get the final polygon and its area.

Analysis

The territory-size of each of the 30 pairs was calculated using the software Google Earth Pro, and means and standard deviations of territory-size were also computed. One-way ANOVA was used to test if the territory-size showed significant variations across different sites. Grubb's test (Extreme Studentized Deviate or ESD) was used to determine if the most extreme estimated maximum territory-size value is a significant outlier from the rest. Distance between the closest GPS points of two adjacent territories was taken as the distance (in m) between them.

RESULTS

The territories were located only in sholas above an altitude of 1,200 m above sea level. *Ochlandra* patches were concluded to be devoid of territories as birds were not detected during searches at these sites. Territories were also not recorded in tea plantations, but a few non-breeding individuals were seen actively foraging at the fringes.

The average territory-size of *S.f. meridionalis* was 2.16±0.68 ha (n=30). No overlap of territories was observed for the 30 pairs tracked and the average distance between adjacent territories was 66.04 m. Grubb's test showed that the maximum territory-size of a pair at Pandipath (0.4183 ha) was furthest from the rest, but was not a significant outlier ($p<0.05$). The estimated maximum territory-sizes did not vary significantly across the study sites ($p<0.07$). The four sites were characterised by similar habitat type, and hence little difference in the territory-sizes across the four sites could be expected.

DISCUSSION

The territorial behaviour of the *Strophocincla* laughingthrushes has not been studied earlier. Though it is well-known for its flocking behaviour in the non-breeding season, this study revealed that *Strophocincla fairbanki meridionalis* is highly territorial and forms pairs during the breeding season. The territorial pairs had given up their territories and were seen in flocks of 6–12 individuals when the sites were revisited in May 2011. This observation leads us to conclude that the taxon, which is otherwise known to occur in flocks, forms pairs and establishes territories during the breeding season that starts from December and continues till April.

Though there has been sporadic work on the nidification of *Strophocincla* spp. of southern India (Bates 1931; Islam 1994), their breeding territories had not been documented. The average territory-size estimated for the subspecies was 2.16 ±0.68 ha during nest-building and incubation stage. This probably varies during the nestling-feeding stage, but could not be determined during the present study. Though no study was undertaken, observations indicate that the home ranges of the flocks were much larger than the territories defended by pairs in the breeding season.

The Agasthyamalai hills have an established network of protected areas, including a tiger reserve and four wildlife sanctuaries, and hence this subspecies of the Kerala Laughingthrush and its habitat is legally well-protected. Additionally, *c.* 275 sq. km, accounting for more than 90% of the Extent of Occurrence (EOO) of the subspecies, falls within the protected area network. This is a boon, as conservation actions that could be taken for the species can be routed through the management plans of these protected areas. However, the habitat faces threats such as the spread of *Ochlandra,* as discussed under Introduction. The continuing impact of man-made fires in its range, particularly areas around Agasthyarkoodam peak, besides illegal felling of trees, will have an adverse impact on the shola forests and pave the way for further proliferation of *Ochlandra* brakes, resulting in adverse effects on the Laughingthrush. Other threats, which have been detrimental to other *Strophocincla* populations in southern India, like the booming eco-tourism (Praveen and Nameer 2011) and spread of tea plantations (Somasundaram and Vijayan 2007) have not been evaluated as major concerns in this region.

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REVIEWS

1. BIRDS OF CENTRAL ASIA by Manuel Schweizer, Raffael Aye, and Tobias Roth. Published by Christopher Helm, London. 2012. Size: 14.5 x 21.5 cm. Pages: 336 with 143 plates. Price: Not mentioned.

This is the first-ever field guide to the birds of Central Asia, here referring to the countries of Kazakhstan, Turkmenistan, Uzbekistan, Kyrgyzstan, Tajikistan, and Afghanistan. The first five countries used to be collectively referred to as Turkestan till this region was annexed to the former Soviet Union. Afghanistan, though not part of Central Asia, is included since a major part of its landscape and birds are similar to those of Central Asia. With the fall of the Iron Curtain that restricted access to 'Turkestan' and the influx of foreign tourists, this book has come at the right time for birders and naturalists touring the country.

The publication covers 618 species of birds, including residents, migrants, and vagrants, all illustrated in 143 excellent and well-designed plates. Two major plus points for the publication are that the common names of species also figure in the plate and that the text for each species faces the relevant plate. These should be the norm for field guides, but may be a bit difficult to follow in regions that have a high diversity of species, as it would make the publication too bulky for the field. The fact that the distribution of species is shown solely by way of distribution maps (and not ideally also in text) make details of these records unavailable for those wanting more information. The status of the species (e.g., common, uncommon, rare) provided for species does compensate for this to some extent. Even in such cases, I feel it would have been better if the status of a species is given at the beginning of the text for one to know its status at the outset.

One thing that strikes a birder from the Indian subcontinent (and this is relevant especially to those from the tropics) on looking at the plates is the overall drabness of the birdlife of the region, not surprising since these are mostly inhabitants of desolate steppes, semi-desert, and stark mountains. This is probably why an image of the lowly and drab Saxaul Sparrow *Passer ammodendri* is used for the cover, with a more drab background to match! It is only the pheasants and some of the few other relatively more colourful species that brighten up the plates. But then, there will always be birders who are more fascinated by Plain Janes!

Besides birds, the publication has the introductory chapters describing the coverage of the book, 'how to use the book', a map of the region, notes on the region's geography and biogeography (with photographs), besides other essential information. Overall, it is an attractive field guide and a must buy for birders of the Central Asian region.

■ RANJIT MANAKADAN

2. ELEPHANT – THE LADY BOSS: ECOLOGY AND MANAGEMENT by C.H. Basappanavar. Published by Vanasuma Prakashana, Bengaluru. 2012. Size: 18.5 x 25 cm. Pages: lxxi + 243 + 52 colour plates. Price: Rs. 1,450/-

The author (C.H. Basappanavar) is a retired Forest Department official of the Karnataka Forest Department, and judging by his writings, he must have been the typical forester of the past generation who lived much more simple lives than the officers of today, who are plagued by the alarming loss of forests, people *versus* forest issues, belligerent and no more docile villagers and tribals, and troublesome politicians. Having been associated with such officers as a wildlife biologist in the 1980s, it would not be wrong to say that they lived the lives of small kings, especially those who forsook the towns and cities and stayed in and around forest areas. Dr. Basappanavar is one of these fortunate souls, plus one of the rare ones who decided to put down his observations and experiences in print.

ELEPHANT – THE LADY BOSS, is the second edition of the book first published in 1998. The suffix 'lady boss' alludes to the social organization of elephants that is matriarchal and where granny is the boss. The loner adult bulls are allowed into the herd only when one of her daughters/granddaughters is ready to mate. This publication provides a wealth of information on the Asian Elephant, its biology, ecology, behaviour, food and feeding habits, breeding biology, and management in captivity. There is also a chapter on myths, legends, folklore, and other such beliefs that are associated with the Asian Elephant. The book is replete with plates on elephants, other wildlife, and habitats. There is also an annexure containing checklists, tables, figures, and other data concerning elephants, and on Bandipur National Park, where the author served as the Field Director for quite a few years. The style of writing is a mix of scientific and popular, which will appeal to both the naturalist and elephant biologist. The author, in some passages, narrates his own field experiences and observations of nature and elephants. He tends to go a bit overboard when the issue of sex in elephants crops up, even to the extent of 'mind-reading' the amorous thoughts of a cow elephant during one sexual encounter he witnessed! Wish I had this gift with humans, leave alone animals or elephants! The book is overall quite informative and a good read.

■ RANJIT MANAKADAN

3. ROMANCING THE ELEPHANT – A STRATEGY TO MITIGATE HUMAN-ELEPHANT CONFLICT

by C.H. Basappanavar. Published by Vanasuma Prakashana, Bengaluru. 2012. Size: 18.5 x 25 cm. Pages: xli + 156 + 52 colour plates. Price: Rs. 1,250/-

ROMANCING THE ELEPHANT – A STRATEGY TO MITIGATE HUMAN-ELEPHANT CONFLICT by Dr. Basappanavar, a retired Forest Department official of the Karnataka Forest Department, deals with the subject of human-elephant conflict, which is becoming a major issue in elephant conservation. This book is largely based on his work on human-elephant conflict for his doctoral thesis in Nagarhole and Bandipur National Parks. Because of this, the book largely provides information on the elephants of these areas, and particularly on human-elephant conflict. There is extensive information and statistical data, in the form of tables and figures, on the two parks and their wildlife, which could serve as reference material for future researchers and foresters working in these areas. Overall, the book is informative, makes interesting reading, and will be of interest to elephant biologists and foresters working in elephant areas, especially in Bandipur, Nagarhole, and Karnataka.

Extremely bizarre was the full-page plate of a painting of an ancient sculpture of Ganesha and Shakti in pre-conjugal ecstasy in this book on human-elephant conflict! It could have been more suited for the author's other publication ELEPHANT – THE LADY BOSS: ECOLOGY AND MANAGEMENT, specifically in the chapter on myths, legends and folklore of elephants. However, even if here, it should figure as a much smaller image 'hidden' among the other illustrations. Wonder why this plate has not caught the eye of Hindu purists and fundamentalists yet?

■ RANJIT MANAKADAN

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MISCELLANEOUS NOTES

1. THE HOOLOCK GIBBON *HOOLOCK HOOLOCK* IN SAIHA, MIZORAM, INDIA: HISTORICAL RECORDS, RECENT SIGHTINGS, AND CONSERVATION ISSUES

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Introduction

The Hoolock Gibbon *Hoolock hoolock* occurs in the westernmost extreme of the distribution range of the 16 gibbon species currently recognised (Geissmann 2007; Kakati *et al.* 2009). Its range between the Brahmaputra and Chindwin rivers encompasses three countries – Bangladesh, India, and Myanmar (Groves 1967). It is the only ape represented in the Indian subcontinent (Geissmann *et al.* 2009). The species has been on the list of the World's 25 Most Endangered Primates since 2006 (Walker *et al.* 2007), with the global population estimated to be about 5,000 animals, of which 2,600 to 4,450 are in India (Choudhury 2006; Molur *et al.* 2005) and about 200 in Bangladesh (Kakati *et al.* 2009; Molur *et al.* 2005). Zonunmawia and Pradhan (2004) state its Mizo name as *hauhuk*, and Lorrain (1951) mentions the Mara name as *veitu*; Mizo and Mara are the two languages used in Saiha.

Mizoram (21,081 sq. km) is part of the north-eastern hill states of India that include Meghalaya, Nagaland, Manipur, and Tripura. Some of the best rainforests of north-east India are found in southern Mizoram, covering parts of Lawngtlai and Saiha districts (Choudhury 2006). The forests of Mizoram are broadly classified as 'Cachar Tropical Evergreen (IB/C3)' and 'Cachar Semi-evergreen (2B/C2)' (Champion and Seth 1968).

Saiha is one of the eight districts of Mizoram, situated at its extreme south and covering an area of 1,965.81 sq. km. Saiha's forests are contiguous with the Blue Mountain National Park (22° 39' N; 93° 02' E; 50 sq. km) of Lawngtlai district (Mizoram) located close to the Myanmar border and the Chin Hills.

Hoolock Gibbons in Saiha

Historical records: Lorrain (1912) provides the earliest records of the occurrence of Hoolock Gibbon in Saiha: "The Gibbon Ape is seen swinging from branch to branch, calling out with its weird, hollow sound… The trees were swarmed with long-tailed monkeys and Gibbon Apes, the latter making no end of noise as the boats approached. The cries of the Gibbon Apes were on every hand, and the experience was indeed a pleasant one to those of an adventurous mind." Parry (1932) in his seminal work on Saiha stated: "Where there is no moon, gibbons are said not to call in the daytime, but as soon as the moon reappears they start shouting again."

Recent records: Hoolock Gibbons occur in all the districts of Mizoram, namely: Aizawl, Champhai, Kolasib, Lawngtlai, Lunglei, Mamit, Saiha, and Serchhip. The main populations, however, survive in the districts of Champhai, Lawngtlai, Lunglei, Mamit, and Saiha (Choudhury 2006). Gupta and Sharma (2005) recorded a total of 72 gibbon groups in seven different populations in Mizoram, in an area of about 298 sq. km. Their survey included all the existing and proposed protected areas and reserve forests. Of the 72 groups recorded in the study, 37 (51.4%) were outside protected areas or reserve forests. There are sizeable populations in southern Saiha and Lawngtlai districts (Choudhury 2006).

My records: During February and March 2009, I was part of a team that undertook surveys towards the formation of Tokalo Wildlife Sanctuary in the area south of Palak lake. In the course of this survey, we recorded the gibbon at three different locations. The call was heard at Lomasu village (22° 6.172' N; 92° 50.859' E) on the banks of Kolodyne river at 10:00 hrs on February 14. The landscape was a mosaic of forest and orchards (primarily banana). The second location (22° 3.048' N; 92° 51.977' E) was adjacent to the Kumai river, where the gibbons were sighted at 08:30 hrs on February 17. The gibbons were calling in a dense forest with good canopy cover. The third location (22° 1.307' N; 92° 52.391' E) was near Rala river at 15:30 hrs, where a juvenile and its mother were seen by colleagues in a dense forest with good canopy cover on February 19. They may be part of a group that was heard the subsequent morning about 200 m further south. Each of these sightings was near a river – the survey was done along these rivers as they would form the boundary of the then proposed wildlife sanctuary.

In addition to the survey results, a juvenile gibbon was seen at the residence of a villager in Saiha. The family had been given the ape by a relative, who had reportedly captured it in the forests of Saiha south of Palak lake.

Conservation Issues

In Mizoram, people believe that possessing a gibbon tooth and a piece of bone will keep them safe from misfortune (Gupta and Sharma 2005). Many Lakhers (Maras) wear bracelets made of gibbon bones to prevent rheumatism, for good health, and to ward off black magic. It is claimed that there would be no smallpox where gibbons occur and that there have never been cases of smallpox in Lakher country for this reason (Parry 1932). Two more prevalent myths in Saiha make the gibbon particularly vulnerable: i) The forelimbs of the gibbon are placed over a pregnant woman's abdomen to lessen her pains during child birth, and ii) Its blood is considered an effective cure for blood pressure and malaria. These myths and other beliefs in the Mara society exacerbate the pressures on wildlife (Ved and Lalramnuna 2008).

Poaching of wildlife, including gibbons, for food and trade is common among the hill tribes of north-east India (Choudhury 2006; Kakati *et al.* 2009; Srivastava 2006). Hunting is culturally sanctioned and widely practiced across the landscape, and hunting pressure has increased with increase in the use of guns and the growing human population. The gibbon faces a higher threat on account of changes in land use. Talks with people in Saiha revealed that the decrease in numbers of large trees in recent years has lead to a decline of the Hoolock Gibbon and hornbills in particular.

Most of the sites with gibbon populations (and other wildlife species) in Mizoram are not under the direct control of the forest authorities, which suggests that a participatory community-based conservation approach, including conservation education, is of utmost importance for wildlife conservation (Gupta and Sharma 2005). Regular programmes focusing on the need for conservation of wildlife, especially charismatic species such as the Hoolock Gibbon, in these remote forested lands is essential. These programmes need to be sensitive to local cultural values and should involve school students, youth associations, village council members, and others that are an integral part of these societies (Ved and Lalramnuna 2008).

ACKNOWLEDGEMENTS

I am indebted to the Forest Department of Mara Autonomous District Council for support and encouragement. Acknowledgements are due to the entire survey team and the local people for sharing their vast knowledge of the region and its wildlife, and for help and cooperation during the survey. Sincere gratitude is due to donors who supported Samrakshan's efforts in Mizoram: Rufford Small Grants, Columbus Zoo, Kidendran Nature Conservation Fund, and United States Fish and Wildlife Service. I thank Kashmira Kakati for discussing gibbons and sharing literature, and two anonymous reviewers for comments on the manuscript.

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2. RECORDS OF THE MELANISTIC LEOPARD *PANTHERA PARDUS* (LINNAEUS) FROM WESTERN GHATS AREA OF MAHARASHTRA AND KARNATAKA, INDIA

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The Leopard *Panthera pardus* (Linnaeus) (Family Felidae, Order Carnivora) is a sleek, short-haired animal, with fulvous coat marked with small close-set black rosettes, distributed all over the sides of body and tail (Prater 1971). The body colour of the animal is highly variable (Prater 1971) from pale yellow, warm grey, rich tawny, to bright rufous fawn. In general, the variations in colour appear due to different environmental conditions like temperature, dryness or humidity, an increase or decrease of light, and/or combinations of these with latitudinal differences from the equator (Prater 1971). Rare occurrences of abnormally black-coloured leopards are of melanistic individuals. A few such instances of the melanistic leopards have been reported in the Western Ghats area of Maharashtra and Karnataka states, which are discussed in this note.

The first author (AS) and members of WLPRESS (Wildlife Protection and Research Society, Satara) have been undertaking systematic research on the reptiles and mammals of Western Ghats of Satara and Kolhapur districts in Maharashtra, since 2006. During these surveys, a 'black leopard' was sighted on three different occasions: December 8, 2010 at 18:30 hrs; March 21, 2012 at 19:00 hrs; and April 13, 2012 at 06:30 hrs. All these sightings were from the same locality – a forested area of the Kaas Plateau (17° 06' N; 73° 08' E) of the Western Ghats in Satara district, Maharashtra, which has been declared as a World Heritage Site by UNESCO.

The fur of this leopard had a dense deposit of melanin and the typical close-set black rosettes were present but hidden beneath the black pigmentation. During the first two instances, it was not possible to take photographs, however, on April 13, 2012, the first author (AS) managed to photograph it using a night vision camera (ed.: photographic evidence provided). We are not sure if the sighting on December 8, 2010, and March 21, 2012, are of the same animal as the one sighted on April 13, 2012.

Other than these records, there is a record of a melanistic leopard in the hilly areas of Western Ghats near Manohar–Mansantosh twin forts between Amboli and Padgaon, Sindhudurg district, Maharashtra on June 3, 2009 (June 14, 2009, *DNA* newspaper, Pune edition). These sightings were by Sachin Kandekar and Abhijit Yadav of Kolhapur. Further, locals and Forest Department personnel had sighted individuals in Chandoli National Park, Sangli district, Maharashtra and in Amboli on a few occasions, but there are no published records available.

In Karnataka, there is a recent sighting of a black leopard in forest along the banks of Bhadra reservoir in Bhadra Tiger Reserve, Chikmagalur district, Karnataka. This leopard was spotted and photographed (ed.: photographic evidence provided) in Bhadra Tiger Reserve by the second author (ST) on February 22, 2012, along with a forest guide, Mr. Girish. Later on, Girish informed ST that he saw the leopard in the same area in April and May, 2012.

Melanism in the leopard is not an uncommon phenomenon. It has been noticed in many animals including mammals. A perusal of literature revealed that there have been reports of melanistic leopards from various parts of India (Ali 1927; Bedi 1998; Pizey 1932; Sinha 1996).

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3. LESSER DAWN BAT *EONYCTERIS SPELAEA*: THE FIRST RECORD FOR BANGLADESH

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Bangladesh harbours diverse species of wildlife in different habitat types ranging from forested hills to low-lying wetlands (Khan 2008; Khan 2010). Occasionally, first records of species are added to the nation's checklist. Recently a bat species, i.e., Lesser Dawn Bat *Eonycteris spelaea*, was recorded in the hilly area of south-eastern Bangladesh (*Daily Prothom Alo* newspaper, August 30, 2012) (Fig. 1). There is no previous report of its occurrence in Bangladesh (Ahmed *et al.* 2009; Khan 2008; Khan 2010).

The roost of around 100 bats was first recorded in a cave called Kudum (21° 05.553' N; 92° 10.166' E; 78 m above msl) in Teknaf Wildlife Sanctuary, Cox's Bazar district, on July 15, 2012. Cox's Bazar is situated in the extreme south-eastern hilly area of Bangladesh. The area was previously covered by rich mixed evergreen forests, which were mostly logged in the course of time, and today, the hills are dominated by bush and plantations. The existence of the bats in the cave was known to many people, including me, for the last several years, but the species was not correctly identified.

This medium-sized bat has an elongated muzzle, which is a key character of the species. Presence of claw only on the thumb (not on the second digit) in the forearm and absence of pale 'fingers' (i.e. pale lines along the digits in dark wings) have helped to differentiate it from similar species that occur in the region, namely Fulvous Fruit Bat *Rousettus leschenaulti* and Short-nosed Fruit Bat *Cynopterus sphinx* (Bates and Harrison 1997; Francis 2008; Menon 2003; Prater 1980). Other than Lesser Dawn Bat, several Blyth's Horseshoe Bat *Rhinolophus lepidus* were seen in the cave. In July 2006, an Intermediate Roundleaf Bat *Hipposideros larvatus* was seen roosting inside the cave.

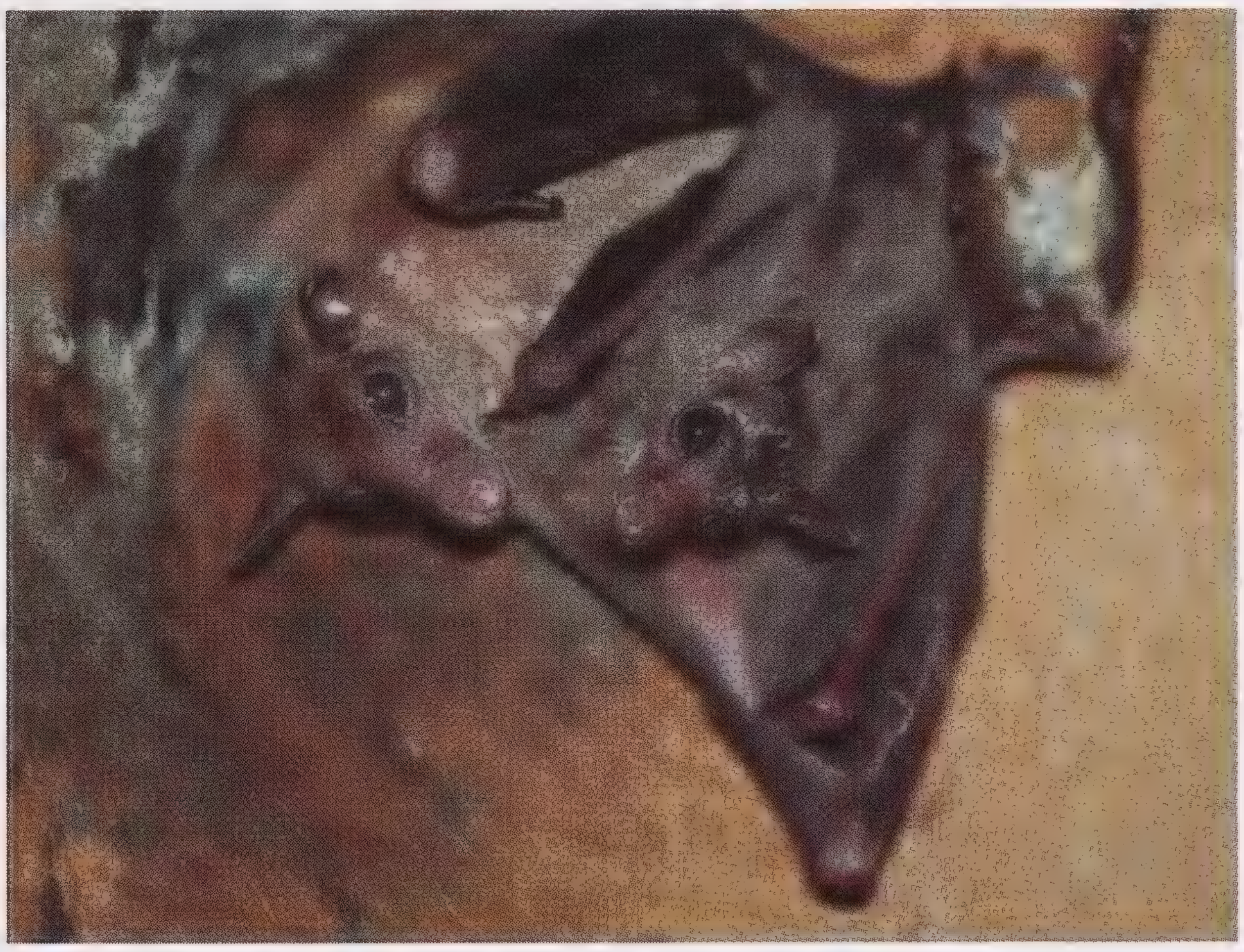

Fig. 1: Lesser Dawn Bat *Eonycteris spelaea* photographed on July 15, 2012, in Kudum Cave, Cox's Bazar, south-eastern Bangladesh

The Lesser Dawn Bat occurs widely in neighbouring India and Myanmar extending to most parts of Southeast Asia, so it was expected to occur in Bangladesh (Khan 2008). Kudum Cave is close (7 km) to the Myanmar border, where the species is known to occur. Based on the pattern of its regional distribution, it is assumed that the species might also occur in the north-eastern and northern areas of Bangladesh, which need to be verified by field surveys.

The existence of Lesser Dawn Bat in Kudum Cave is threatened due to rapid deforestation in the area, which contributes to the decline of food resources since it feeds on pollen and nectar (Francis 2008). Additionally, the existence of the cave is threatened due to frequent landslides during the monsoon. It was observed that the bat population in the cave has declined to nearly half since June 2008 (when counts were done prior to its identity being confirmed).

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4. REAPPEARANCE OF THE WILD PIG *SUS SCROFA CRISTATUS* IN DACHIGAM NATIONAL PARK, KASHMIR, INDIA

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Dachigam National Park (34° 05'–34° 11' N; 74° 54'–74° 09' E; 141 sq. km), is located 22 km from Srinagar and lies in the Zanskar mountain range of the North-West Himalayan Biogeographic Zone (2A) [Rodgers and Panwar (1988): Planning a wildlife protected area network in India. Wildlife Institute of India Press, Dehradun]. Dachigam National Park (DNP) was established by the then Maharaja of Jammu & Kashmir Hari Singh by evacuating ten villages to serve exclusively as a hunting preserve for his guests. It was declared as a Game Sanctuary in 1951 and notified as National Park in 1981. DNP is significant as being home to the last surviving population of the highly endangered and endemic deer of Kashmir, the Kashmir Red Deer or Hangul. The other major mammal species found in Dachigam are Musk Deer *Moschus chrysogaster*, Serow *Capricornis sumatraensis*, Himalayan Grey Langur *Semnopithecus ajax*, Asiatic Black Bear *Ursus thibetanus*, Brown Bear *Ursus arctos*, Leopard *Panthera pardus*, Red Fox *Vulpes vulpes*, Jackal *Canis aureus*, Small Indian Civet *Viverricula indica*, and Pine Marten *Martes flavigula.* The Snow Leopard *Panthera uncia* is also reported.

According to Walter Lawrence (1895), in his book THE VALLEY OF KASHMIR (p. 117), the Wild Pig was introduced in the mountains of Kashmir and in Dachigam forests during the time of the Dogra ruler of Jammu & Kashmir, Maharaja Gulab Singh (1846–1857). After its introduction, it became very common in the preserves and along the foothills of the mountains on the eastern side of the valley [Lawrence (1895): "The Valley of Kashmir". London H. Frowde Publishers. 478 pp.]. After independence in 1947, the people of Kashmir expressed concern over the presence of the Wild Pig, especially in Dachigam Sanctuary, and due to mass agitations by the locals steps were taken to eradicate the alien species from the Kashmir forests. The last population of Wild Boar is reported to have been wiped out from Dachigam during the 1980s, and according to the State Wildlife Department, it has never been reported from Dachigam National Park or its adjoining forests since 1984.

On April 07, 2013, at 16:00 hrs, we came across a sighting of the Wild Pig on the main road in the lower Dachigam near *Lelchamb* at 1,750 m elevation during a survey for Hangul. This sighting was recorded after an absence of nearly 30 years. The animal was moving towards the woods along the main Dachigam *nullah.* One of our team members, Nazir Malik, the Wildlife Forest Guard, managed to photograph the animal. On April 9, we again sighted probably the same animal at 17:00 hrs in a riverine patch of Wasantpora in Lower Dachigam. On May 30, 2013, at 04:39 hrs, we got a picture of the species, probably a male, in a camera trap in the riverine patch near the Rescue Centre, close to the Park gate. Earlier last year, a solitary individual was sighted in the forests of Ajas Conservation Reserve in Bandipora.

These sightings indicate that the Wild Pig is making a comeback in Dachigam. However, like other introduced species, its recurrence may have long-term ecological implications, especially for endemic faunal species, particularly the Kashmir Red Deer or Hangul, and hence the species needs to be eradicated or its population controlled. It will be interesting to find out where these individuals have come from, and a study could be undertaken to monitor its population and the impacts of its reappearance on the habitat and local fauna.

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5. RECORD OF THE GREAT WHITE PELICAN *PELECANUS ONOCROTALUS* IN MYSORE, KARNATAKA, INDIA

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The Great White Pelican *Pelecanus onocrotalus* is distributed through Eastern Europe, Middle East, Africa, and parts of Asia (BirdLife International 2014). In the Indian subcontinent, it is recorded as a common winter visitor to Pakistan and northern India (Punjab to Assam and Gujarat) (Ali and Ripley 1987; Lahkar and Deka 2001; Talukdar *et al.* 1998; Tatu 1992; Urfi 1996; Varu and Khatri 1992; Varu and Tiwari 1994). The species was once recorded breeding in the Great Rann of Kachchh (Ali 1960).

There have been occasional sight records in Andhra Pradesh (Law 1925; Nanjan and Vijayan 2009; Taher and Mani 2008), Kerala (Jacob *et al.* 1994; Nair 1993), and Tamil Nadu (MigrantWatch 2009). It is also been reported to breed in parts of Gujarat (Ali 1960; Pandya and Vachhrajani 2010) and Delhi (Urfi 1996). In Karnataka, the species been reported from Udupi (Bhatt and Pushpalatha 2003). It is vagrant in Sri Lanka (Harrison 2011).

During the course of our routine field visits for birding, we came across a lone Great White Pelican in Kukkarahalli tank in Mysore on February 04, 2012. We could distinguish it from Spot-billed Pelican *Pelecanus philippensis*, which is resident in the tank, by the white plumage and black marginal feathers. The colour of the pouch beneath its beak was yellow and the feet were pinkish. We observed this bird for more than 15 minutes and managed to get some photographs too. Kukkarahalli tank is a medium sized water body and designated as an Important Bird Area, where about 207 species of birds have been recorded (MAN 1997). Some of the important species include the Spot-billed Pelican, Oriental Darter *Anhinga melanogaster*, Painted Stork *Mycteria leucocephala*, and Oriental White Ibis *Threskiornis melanocephalus*, all of which breed in the tank.

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6. SIGHTING OF LONG-TAILED DUCK *CLANGULA HYEMALIS* IN GHARANA WETLAND, JAMMU & KASHMIR, INDIA

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Gharana Wetland, a winter refuge for migratory birds, is important as a staging site and flyway route. It is a small wetland, spread over 0.75 sq. km, just 28 km away from Jammu City. Gharana Wetland got its name from Gharana village which is very close to the Indo-Pak border at Ranbirsinghpora *tehsil* in Jammu district in the state of Jammu & Kashmir. Gharana Wetland has been declared as an Important Bird Area (IBA), based on BirdLife criteria A4iii (hosts more than 20,000 waterbirds). It is protected as a Wetland Conservation Reserve (Rahmani *et al.* 2012).

A part of this wetland lies across the border in Pakistan. During March 2013, Tufted Pochard *Aythya fuligula* was reported in Gharana Wetland, close to the Indo-Pakistan border in Ranbirsinghpora. To capture pictures of these birds, I visited the wetland a number of times. During one such trip, I spotted a small bird in the camera viewfinder (and photographed it), which I had never seen there before. It had white on the flanks and face, and the rest of the body was a mixture of black, and brown. I spotted the bird again the next day and took more photographs.

On my queries to BNHS for help in its identification, I got a prompt reply that it was a female Long-tailed Duck *Clangula hyemalis* in non-breeding plumage. This species is listed as Vulnerable (IUCN 2013). I was also informed that there were only four records of the species from the Indian region, one each from Kashmir, Uttar Pradesh, Nepal, and Arunachal, and so this would be another rare record of this straggler for India and for Jammu & Kashmir.

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7. BANDED KRAIT *BUNGARUS FASCIATUS* FEEDING ON COMMON KRAIT *BUNGARUS CAERULEUS*

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The *Dainik Bhaskar* (a Hindi daily), Raipur edition, dated September 04, 2012, published a news item with photographs, describing a Banded Krait *Bungarus fasciatus* feeding on a Common Krait *Bungarus caeruleus*. This incident was observed by villagers of Tapkara (22° 44' 52" N; 83° 57' 24" E), 45 km from Jashpurnagar, Chhattisgarh, and the newspaper's correspondent-videographer Shri Shashikant Pandey at Jashpurnagar, who filmed it. The film showed the *c.* 2 m long Banded Krait catching hold of the metre long Common Krait near the head, subduing it, and swallowing it completely within 25 minutes.

The diet of the Banded Krait in the accounts in available literature are: "small mammals, lizards, snakes and toads" (Gunther 1864); "mainly snakes and among those taken are Rat Snake, Indo-chinese Rat Snake, Cat Snake, Checkered Keelback, Buff-striped Keelback, also skinks, eggs of snakes and occasionally fish" (Daniel 2002; Deoras 1981); "eats water snakes, rat snakes, pythons, and vine snakes, besides lizards, frogs and fish" (Das 2002); "feed on other snakes including venomous snakes, show cannibalism as they can also devour other kraits under the conditions of food scarcity, also feed on small lizards" (Maurice 2009).

The video recording discussed in this note confirms that the Banded Krait feeds on snakes as reported by other workers, and also on other krait species, which is in this reported case was the Common Krait.

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8. MARINE ORNAMENTAL ICHTHYOFAUNA OF THOOTHUKUDI COAST, GULF OF MANNAR, INDIA

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Introduction

Coral ecosystems are one of the most important coastal life support systems, and support a variety of economically important marine organisms. With its 21 coral islands, the Gulf of Mannar (GoM) has a heterogeneous assemblage of fauna and flora. Nearly 3,600 species are reported from this coral ecosystem (Ramadhas *et al.* 1999). Tuticorin coast, a part of GoM, is bestowed with unique fishery resources, such as Pearl Oyster *Pinctada fucata* and Sacred Chank *Turbinella pyrum*. The Tuticorin coastal habitat consists of four coral islands, seagrass beds, and mangroves. A large number of colourful animals from all phyla are represented in this region, including fish of vibrant and attractive colours, which have a high demand in the international ornamental fish market.

In terms of commercial value, marine ornamental fish are priced at US$ 1,000 per kg, which is nearly 330 times higher than the price of food fish and ten times higher than freshwater ornamental fish (Surtida 1999). Though the world wholesale market value of live ornamental fish is estimated as US$ 900 million (Bassleer 1994), only 10% volume comes from marine ichthyofaunal collections. Organised fishing for marine ornamental fish has recently started in some Southeast Asian countries. Presently, marine ornamental fish represent a small percentage of the ornamental fish trade in India. However, their high market value makes it economically attractive for creating sustainable livelihood resources for coastal fisherman communities. With the increasing expansion of the global marine ornamental fish trade, studies on these resources are vital for optimally exploiting these under-utilised resources and to preserve the biodiversity.

The fishery wealth of the coral reefs of Tuticorin has been studied earlier by Bennet and Arumugam (1991), Kasim *et al.* (1989), Mahadevan and Nayar (1967), Manikandavelu (1996), and Mathew (1994). However, specific studies on the ornamental fish fauna in Tuticorin waters are limited. With levelling or decline in production from many capture fisheries in this region, other ways of using the valuable aquatic resources is the need of the hour. In this regard, a study was initiated to document the ornamental marine ichthyofaunal resources of Tuticorin.

Methods

Colourful fish species recorded at different fish landing centres of Tuticorin district were collected regularly from April 2000 to March 2001. The catches of both mechanised boats and traditional crafts were examined, and the fish species were categorised as rare, frequent, and abundant based on the fish landings. The specimens were identified based on Fischer and Bianchi (1984), Jones and Kumaran (1980), and Munro (1955).

Results

The collections consisted of 107 ornamental fish species under 37 families (Table 1). Manikandavelu (1996) had recorded 222 coral reef fishes from this region, 76 falling under the marine ornamental fish category. Of the 138 species of marine ornamental fishes reported by Murthy *et al.* (1989) from the Lakshadweep region, 47 species occur in the Tuticorin area. Of the 107 species recorded during our collections, 53.3% were rare, 35.5% frequent, and 11.2% were abundant. Twelve families are represented by single species while nine families are represented by two species.

Acanthuridae was the most dominant family, represented by 12 species. Of the five genera of Acanthurids recorded from the region (Fischer and Bianchi 1984), *Acanthurus* and *Naso* represented the ornamental fishes. *Acanthurus leucosternon*, *A. lineatus*, and *Naso lituratus* are

Table 1: Marine ornamental ichthyofauna found in Tuticorin Coast

Sl. No.	Scientific Name		Common Name	Abundance
1.	**F: Acanthuridae**		**Surgeonfishes**	
	1.	*Acanthurus blochii*	Tailring surgeonfish	Rare
	2.	*Acanthurus gahhm*	Black surgeonfish	Rare
	3.	*Acanthurus leucosternon*	Powder-blue surgeonfish	Rare
	4.	*Acanthurus lineatus*	Blue-banded surgeonfish	Rare
	5.	*Acanthurus mata*	Elongate surgeonfish	Rare
	6.	*Acanthurus nigricaudus*	Epaulette surgeonfish	Rare
	7.	*Acanthurus nigrofuscus*	Brown surgeonfish	Rare
	8.	*Acanthurus tennenti*	Double band surgeonfish	Rare
	9.	*Acanthurus triostegus*	Convict surgeonfish	Rare
	10.	*Naso brevirostris*	Spotted unicornfish	Frequent
	11.	*Naso lituratus*	Orange-spined unicornfish	Frequent
	12.	*Naso unicornis*	Blue-spined unicornfish	Rare
2.	**F: Ambassidae**		**Glassfishes**	
	1.	*Ambassis commersonii*	Glassy perchlet	Frequent
3.	**F: Balistidae**		**Triggerfishes**	
	1.	*Balistapus undulatus*	Orange lined triggerfish	Frequent
	2.	*Balistoides viridescens*	Titan triggerfish	Frequent
	3.	*Odonus niger*	Black triggerfish	Frequent
	4.	*Pseudobalistes fuscus*	Blue lined triggerfish	Rare
	5.	*Sufflamen chrysoptera*	Halfmoon triggerfish	Frequent
	6.	*Sufflamen fraenatus*	Masked triggerfish	Frequent
4.	**F: Canthigasteridae**		**Pufferfishes**	
	1.	*Canthigaster solandri*	Spotted sharp-nosed puffer or Toby	Rare
5.	**F: Carangidae**		**Travellies**	
	1.	*Gnathanodon speciosus*	Golden-toothed travelly	Frequent
	2.	*Alectis indicus*	Indian threadfin travelly	Abundant
6.	**F: Chaetodontidae**		**Butterflyfishes**	
	1.	*Chaetodon auriga*	Threadfin butterflyfish	Rare
	2.	*Chaetodon collare*	Red tail butterflyfish	Rare
	3.	*Chaetodon unimaculatus*	One spot butterflyfish	Rare
	4.	*Chaetodon vagabundus*	Vagabond butterflyfish	Rare
	5.	*Ctenochaetus strigosus*	Spotted surgeonfish	Rare
	6.	*Heniochus acuminatus*	Pennant coral fish	Frequent
7.	**F: Cichlidae**		**Chromide**	
	1.	*Etroplus maculatus*	Orange chromide	Rare
	2.	*Etroplus suratensis*	Green chromide or pearlspot	Frequent
8.	**F: Diodontidae**		**Porcupinefishes**	
	1.	*Diodon hystrix*	Spotted porcupinefish	Frequent

Table 1: Marine ornamental ichthyofauna found in Tuticorin Coast (*contd.*)

Sl. No.	Scientific Name	Common Name	Abundance
9.	**F: Drepanidae**	**Sicklefishes**	
	1. *Drepane punctata*	Spotted sicklefish	Frequent
10.	**Ephippidae**	**Spadefishes and batfishes**	
	1. *Ephippus orbis*	Orbfish	Rare
11.	**F: Gerreidae**	**Mojarras**	
	1. *Gerres erythrourus*	Deep bodied mojarra	Frequent
	2. *Gerres filamentosus*	Whipfin silverbelly	Frequent
	3. *Gerres oyena*	Common silver-biddy	Frequent
12.	**F: Haemulidae**	**Grunts and Sweetlips**	
	1. *Plectorhinchus flavomaculatus*	Lemon sweetlips	Rare
	2. *Plectorhinchus orientalis*	Oriental sweetlips	Rare
	3. *Plectorhinchus polytaenia*	Ribboned sweetlips	Rare
	4. *Diagramma pictum*	Painted sweetlips	Abundant
13.	**F: Holocentridae**	**Squirrelfish**	
	1. *Myripristis botche*	Black tip soldierfish	Rare
	2. *Myripristis murdjan*	Pine cone soldierfish	Rare
	3. *Sargocentron rubrum*	Red coat fish	Frequent
14.	**F: Labridae**	**Wrasses**	
	1. *Pseudocheilinus hexataenia*	Pyjama wrasse	Rare
	2. *Cheilinus chlorourus*	Floral wrasse	Rare
	3. *Coris angula*	Clown coris	Rare
	4. *Coris formosa*	Queen coris	Frequent
	5. *Coris gaimard*	Yellowtail coris	Rare
	6. *Iniistius pavo*	Peacock wrasse	Frequent
15.	**F: Lutjanidae**	**Snappers**	
	1. *Lutjanus fulviflammus*	Dory snapper	Frequent
	2. *Lutjanus fulvus*	Black tail snapper	Abundant
	3. *Lutjanus kasmira*	Blue-striped snapper	Frequent
	4. *Lutjanus sebae*	Red emperor	Frequent
	5. *Macolor niger*	Black and white snapper	Rare
16.	**F: Malacanthidae**	**Blue whitting**	
	1. *Malacanthus latovittatus*	Blue whitting	Rare
17.	**F: Menidae**	**Moonfishes**	
	1. *Mene maculata*	Moonfish	Frequent

Table 1: List of marine ornamental ichthyofauna found in Tuticorin Coast (*contd.*)

Sl. No.	Scientific Name		Common Name	Abundance
18.	**F: Monocanthidae**		**Filefishes**	
	1.	*Pervagor tomentosus*	Red-tailed filefish	Rare
	2.	*Cantherhines pardalis*	Honeycomb filefish	Rare
19.	**F: Monodactylidae**		**Fingerfishes**	
	1.	*Monodactylus argenteus*	Silver batfish or Ceylon angel	Frequent
20.	**F: Mullidae**		**Goatfishes**	
	1.	*Upeneus tragula*	Black-striped goatfish	Frequent
	2.	*Upeneus vittatus*	Yellow-striped goatfish	Frequent
	3.	*Parupeneus indicus*	Indian goatfish	Abundant
21.	**F: Muraenidae**		**Moray eels**	
	1.	*Echidna nebulosa*	Snow flake moray	Rare
	2.	*Gymnothorax favagineus*	Laced moray	Rare
22.	**F: Nemipteridae**		**Threadfin breams**	
	1.	*Nemipterus bipunctatus*	Delagoa threadfin bream	Abundant
	2.	*Nemipterus japonicus*	Japanese threadfin bream	Abundant
	3.	*Scolopsis bimaculatus*	Thumbprint monocle bream	Abundant
	4.	*Scolopis vosmeri*	Whitecheek monocle bream	Frequent
23.	**F: Ostraciidae**		**Boxfishes**	
	1.	*Tetrosomus gibbosus*	Hump-backed turretfish	Rare
	2.	*Lactaria cornuta*	Longhorn cowfish	Rare
	3.	*Lactoria fornasini*	Throneback cowfish	Rare
	4.	*Ostracion cubicus*	Yellow boxfish	Rare
24.	**F: Platacidae**		**Batfishes**	
	1.	*Platax orbicularis*	Orbicular batfish	Rare
	2.	*Platax teira*	Long-finned batfish	Rare
25.	**F: Pomacanthidae**		**Angelfishes**	
	1.	*Pomacanthus annularis*	Blue ring angelfish	Rare
	2.	*Pomacanthus imperator*	Emperor angelfish	Rare
	3.	*Pomacanthus semicirculatus*	Semi circle angelfish or Koran angelfish	Rare
	4.	*Centropyge multispinis*	Dusky angelfish	Rare
26.	**F: Pomacentridae**		**Damselfishes**	
	1.	*Amphiprion clarkii*	Yellow-tailed anemonefish	Rare
	2.	*Amphiprion sebae*	Sebae anemonefish	Frequent
	3.	*Amphiprion percula*	Orange clownfish	Rare
	4.	*Chromis caerulea*	Blue green damselfish	Rare
	5.	*Dascyllus trimaculatus*	Three spot damselfish	Rare
	6.	*Abudefduf saxfasciatus*	Scissortail sergeant major	Rare

Table 1: Marine ornamental ichthyofauna found in Tuticorin Coast (*contd.*)

Sl. No.		Scientific Name	Common Name	Abundance
27.		**F: Scaridae**	**Parrotfishes**	
	1.	*Scarus gibbosus*	Parrotfish	Frequent
	2.	*Scarus rivulatus*	Rivulated parrotfish	Rare
28.		**Scatophagidae**	**Scats**	
	1.	*Scatophagus argus*	Spotted scat	Frequent
29.		**F: Scorpaenidae**	**Scorpionfishes**	
	1.	*Dendtrochirus zebra*	Zebra turkeyfish	Rare
	2.	*Pterois volitans*	Red lionfish	Rare
	3.	*Pterois radiata*	Radial firefish	Rare
30.		**F: Serranidae**	**Groupers**	
	1.	*Epinephelus flavocaeruleus*	Blue and yellow reef-cod	Rare
	2.	*Epinephelus hexagonatus*	Star-spotted grouper	Abundant
	3.	*Epinephelus malabaricus*	Malabar reef-cod	Abundant
	4.	*Epinephelus merra*	Honeycomb grouper	Abundant
	5.	*Epinephelus undulosus*	Wavy-lined reef-cod	Rare
31.		**F: Siganidae**	**Rabbitfishes**	
	1.	*Siganus canaliculatus*	White-spotted spinefoot	Frequent
	2.	*Siganus javus*	Streaked spinefoot	Frequent
	3.	*Siganus vermiculatus*	Vermiculated rabbitfish or Jigsaw puzzlefish	Abundant
32.		**F: Syngnathidae**	**Sea Horses and Pipefishes**	
	1.	*Hippocampus kuda*	Spotted sea horse	Frequent
	2.	*Corythoichthys flavofasciatus*	Banded pipe fish	Frequent
33.		**F: Synodontidae**	**Lizardfish**	
	1.	*Synodus variegatus*	Variegated lizardfish	Rare
34.		**F: Theraponidae**	**Tiger perches**	
	1.	*Therapon buta*	Small-scaled terapon	Frequent
	2.	*Therapon jarbua*	Target perch	Abundant
35.		**F: Tetradontidae**	**Bufferfish**	
	1.	*Arothron hispidus*	White-spotted bufferfish	Frequent
	2.	*Arothron nigropunctatus*	Black-spotted bufferfish	Frequent
36.		**F: Triacanthidae**	**Triplespines or Tripodfishes**	
	1.	*Triacanthus biaculeatus*	Black-finned triplespine	Frequent
37.		**F: Zanclidae**	**Moorish Fishes**	
	1.	*Zanclus cornutus*	Moorish Idol	Rare

the most colourful species collected from this family. Chaetodontidae, usually found in reef areas and renowned for their multihued colour patterns (Allen and Steene 1987), are represented by six species. This is the most important group of ornamental fishes on the coast in terms of demand for aquarium keeping, but they were found to be rare in the Tuticorin waters. Other families recorded and represented by six species each are Balistidae, Labridae, and Pomacentridae. Among triggerfish, reasonable catches of *Odonus niger* were reported from both trawl and traditional gear. Some of the triggerfish species fetch as much as $200 for a live specimen.

Labridae is also fairly represented in this region. These wrasses exhibit a range of colour patterns and are best suited for aquariums. Of the estimated 120 species belonging to 27 genera found in the Indo-Pacific (Allen and Steene 2000), six were recorded in the study area. Among the Pomacentrids, the damselfishes are found in shallow seas, living in close association with sea anemones, and are easily collected by skin diving. There are six species represented from this family, three belonging to genus *Amphiprion* and one each representing genera *Chromis*, *Abudefduf* and *Dascyllus*. The Pomacanthidae (marine angelfishes) were represented by four species. The best-suited, easy maintenance marine aquarium fish, the pygmy angelfishes of the genus *Centropyge* of this family were rarely observed. Nearly 200 species of Lutjanids are commonly kept in aquarium tanks and in public aquariums (Burgees *et al.* 1990). Of the 22 Lutjanid species listed from the coral reef regions of Tuticorin by Manikandavelu (1996), only five species could be treated as marine ornamental fish – all the 22 species were recorded during this study. Goatfishes, the mullids, bearing two chin barbels were represented by three species.

Turkeyfish or lionfish are very attractive, with long filamentous extension to the dorsal and pectoral fin rays and spines. Three species known for their hardiness were recorded, but were rare. Among the eels, moray eels – particularly *Echidna nebulosa* and *Gymnothorax favagineus* – were recorded. Other eels like Congridae, Moringuidae, and Ophichthidae were not recorded in the landings; this may be due to the selective gear operated by the fishermen. *Gymnothorax undulatus* and *G. punctatus* of Muraenidae, though reported earlier by Mahadevan and Nayar (1967), were not recorded during this study.

Of the 12 species of seahorses (*Hippocampus*) found in the Indian Ocean (Allen and Steene 1987), only *Hippocampus kuda* is fairly common in this region. They can be easily collected and kept in aquariums. However, as per the Ministry of Environment and Forests notification, seahorses are listed under the Schedule I category and collecting them from the wild is strictly prohibited. The pipefish *Corythoichthys falvofasciatus* was another rare species collected under family Syngnathidae, which includes seahorse and pipefishes.

Most of the groupers (Serranidae) are favourite food fish. Though most of them are colourful, only four can be considered as ornamental due to their relatively small size; all are hardy species of the genus *Epinephelus*. While juveniles of grunts (Hemulids) show bright colours, the colour pattern gradually fades with growth. Young specimens of batfish, particularly *Platax teira* exhibit spectacularly elongated dorsal and anal fins. With growth, these fins become proportionately shorter. Relatively slow moving, the sluggish boxfishes (Ostraciidae) are represented by four species. The squirrelfishes (Holocentridae), represented by four species are usually brightly coloured. They are carnivorous and nocturnal in nature. Canthigasteridae, the bufferfishes, are usually sluggish, and were represented by a single species *Canthigaster solandri*. *Zanculus* (Zanclidae), a universally favoured marine ornamental fish with highly contrasting pattern and graceful shape, is also represented, but was recorded to be rare.

Other than marine species, brackish-water species such as *Etroplus*, *Monodactylus*, *Scatophagus*, *Ambassis*, and *Gerres*, were reported to be collected from nearby brackish-water areas and coastal areas by minor gears and sold for the aquarium trade.

Discussion

Based on the collections made, it appears that nearly 107 species can be collected with the gear currently used by the fishermen. Species living in crevices and caves, such as Pseudochromidae, Plesiopidae, and Priacanthidae were not recorded, which points to the need for specific gear to catch such species, and if done so, the species diversity of ornamental fishes from Tuticorin will be higher than recorded during this study. However, most of the species of ornamental fish species recorded (107 species) were found to be low in numbers. At present a limited number of ornamental fish species have been exploited from Gulf of Mannar region, particularly the Chinna Ervadi, Keelakarai, and Thoothukudi. The following measures are suggested to document and conserve the ichthyofaunal diversity of the region:

- Encourage the fishermen to responsibly exploit the high valued ornamental fishes from this region.
- Studies need to be taken up to assess the relative abundance, distribution, habitat requirements, and biology of the marine ornamental fishes.
- Fishing has to be regulated to ensure that the critical viable stock level is maintained, with regulation of mesh

size of gill nets and hook size for long line to prevent large scale capture of juvenile fish. The mesh size of the entrance to traps should also be increased.

- Strengthening the existing Gulf of Mannar Marine Park and Biosphere Reserve by expanding the ecologically importance areas of marine ornamental fishery resources.
- Strict implementation of WPA (1972) to protecting coral, seagrass, and other important marine resources and ecosystems.
- Rehabilitating fishermen who are engaged in unlawful fishing methods to ecofriendly methods.
- Establishment of closed areas, especially to protect the spawning aggregation sites of ornamental fishes.
- Creating awareness on the importance of conservation of marine ornamental ichthyofauna among fishermen and villagers living along the coast.

ACKNOWLEDGEMENTS

The authors wish to acknowledge Dr. R. Santhanam, former Dean and Dr. G. Sugumar, Dean I/C, Fisheries College and Research Institute, Thoothukudi, India, for their constant encouragement and constructive criticism.

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9. KHARE'S STREAM FROG *PTERORANA KHARE* – A NEW RECORD FOR BANGLADESH

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On October 3, 2012, at 19:30 hrs, an individual of *Pterorana khare* was found in a rocky hill stream at 580 m altitude in Rumana (21° 57' 562" N; 92° 32' 853" E), Ruma, Bandarban, situated in the south-eastern hill range of the Chittagong Hill Tracts, close to the border of Mizoram state of India. The area has a mosaic of patchy, mixed evergreen forests and shifting cultivation. The specimen was collected for study and was preserved as a permanent voucher specimen (Registration No. JUHG-0337) in the Animal Museum of the Department of Zoology, Jahangirnagar University, Dhaka.

The specimen revealed the unique skin flap on the flanks, which is a unique character for the species. A skin flap was also present along the inner border of the thighs. Its snout-vent length was 68 mm. Tibio-tarsal articulation reached to snout tip. A distinct tubercle was present at the angle of jaws. Forelimbs were short and hind limbs were long. Fingers were free and toes were fully webbed; each of the digits had oblong disc at the terminal end. It had greenish-slaty upperparts and white (anterior) to yellowish (posterior) underparts. Dark tympanum was nearly half the diameter of eye. Iris was golden in colour and pupil was horizontal. Pale dorso-lateral line was present. Hind limbs had dark cross-bands. The characteristics match the published characteristics of *Pterorana khare* (Chanda 2002; Kiyasetuo and Khare 1986). The local Bawm tribesmen, who occasionally catch frogs for meat, report that this species is rare in the area, referring to it as 'vun-dor', which means 'loose skin', indicating its unique skin flap.

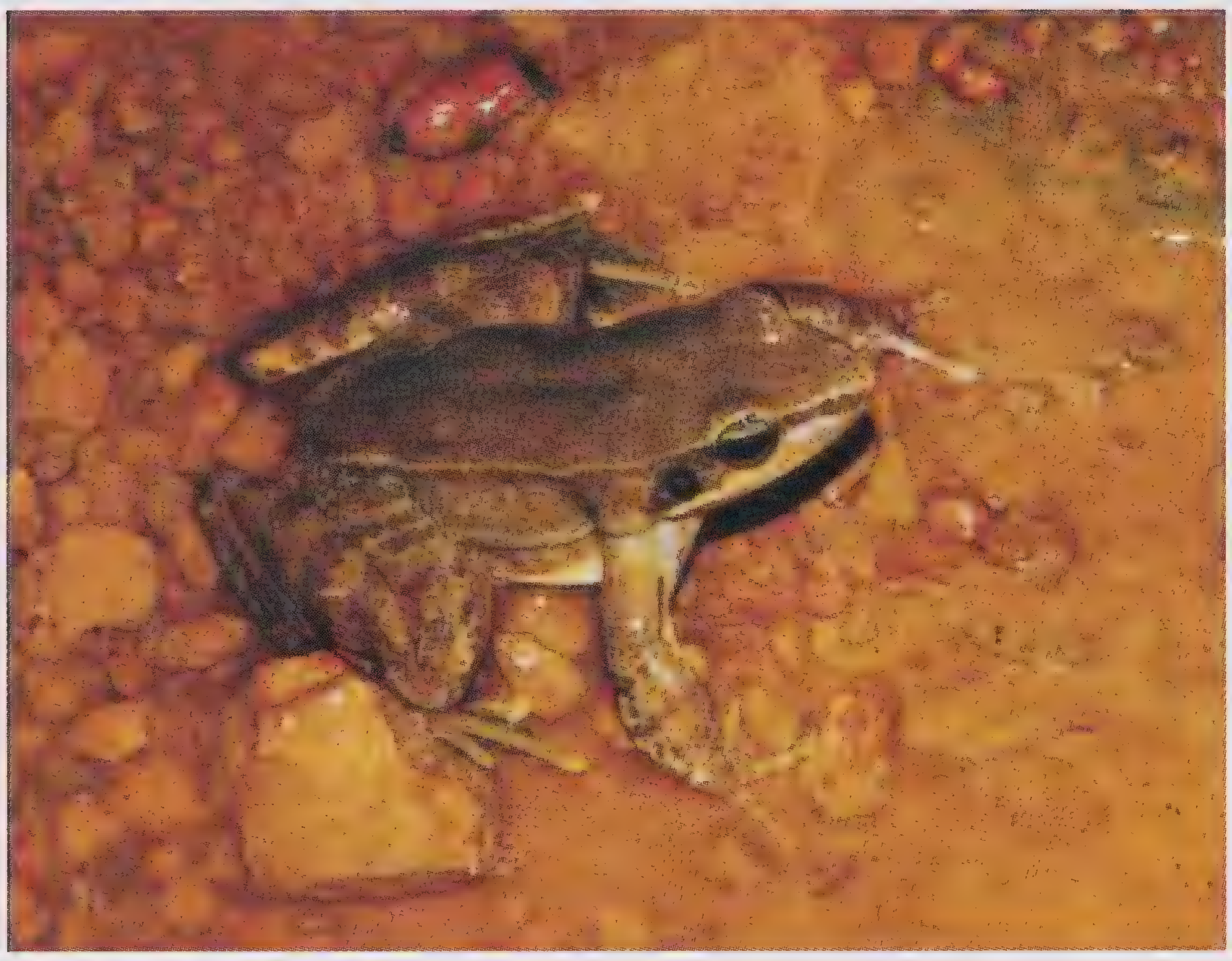

Fig. 1: *Pterorana khare* from Bandarban, south-eastern Bangladesh, on October 3, 2012

Pterorana khare, listed as Vulnerable by the IUCN, is known from a few localities in north-eastern India (Nagaland and Assam) between 200–1,600 m altitude. Its distributional range was presumed to be wider (IUCN 2012), which is now proved by its occurrence in Bangladesh. A thorough survey on its distribution and population status in the hilly areas of south-eastern and north-eastern Bangladesh is required to ascertain its status in the country.

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10. ON A RECORD OF *RHYNCHOCINETES DURBANENSIS* GORDON, 1936 (DECAPODA, CARIDEA, RHYNCHOCINETIDAE) IN THE GULF OF MANNAR, TAMIL NADU, INDIA

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Introduction

The family Rhynchocinetidae consists of reclusive, small, red and white shrimps that are often seen in large associations, and characterised by their upward hinged foldable rostrum. It comprises 25 species under two genera *Cinetorhynchus* (11 species) and *Rhynchocinetes* (14 species) (Ahyong *et al.* 2011; De Grave and Fransen 2011). The genus *Rhynchocinetes* is easily recognisable by the movable rostrum, which is jointed with the carapace by an articulation and by its vivid red and white colour patterns. The male is easily distinguishable by the presence of elongated maxillipeds above the rostral tip and larger chela of first pereiopods (Gordon 1936).

The family Rhynchocinetidae has not been much reported from Indian waters. Kemp (1925) contributed to the first occurrence of this taxa in Indian waters, namely *Rhynchocinetes hendersoni* Kemp from the Gulf of Mannar, Andaman and Nicobar Islands (Kemp 1925; Radhakrishnan *et al.* 2012), which was recently re-designated as *Cinetorhynchus hendersoni* (Kemp, 1925). After this, and a gap of many decades, Dinesh and Zacharia (2007) and Zacharia *et al.* (2008) reported the presence of another species, namely *R. durbanensis* Gordon off the Karnataka coast. A recent checklist on caridean shrimps of Indian waters (Radhakrishnan *et al.* 2012) reports only single species from both the genus *Cinetorhynchus* and *Rhynchocinetes.*

In this note, we provide details of specimens of *Rhynchocinetes durbanensis*, based on five individuals, collected by us from the coasts of Tuticorin. The shrimps were collected around submerged rocks by hand nets at a depth of 2–3 m while snorkelling. They were carefully transferred to the laboratory without causing damage to the body and pereiopods. The specimens were preserved in 5% sea water formalin and deposited in the National Zoological

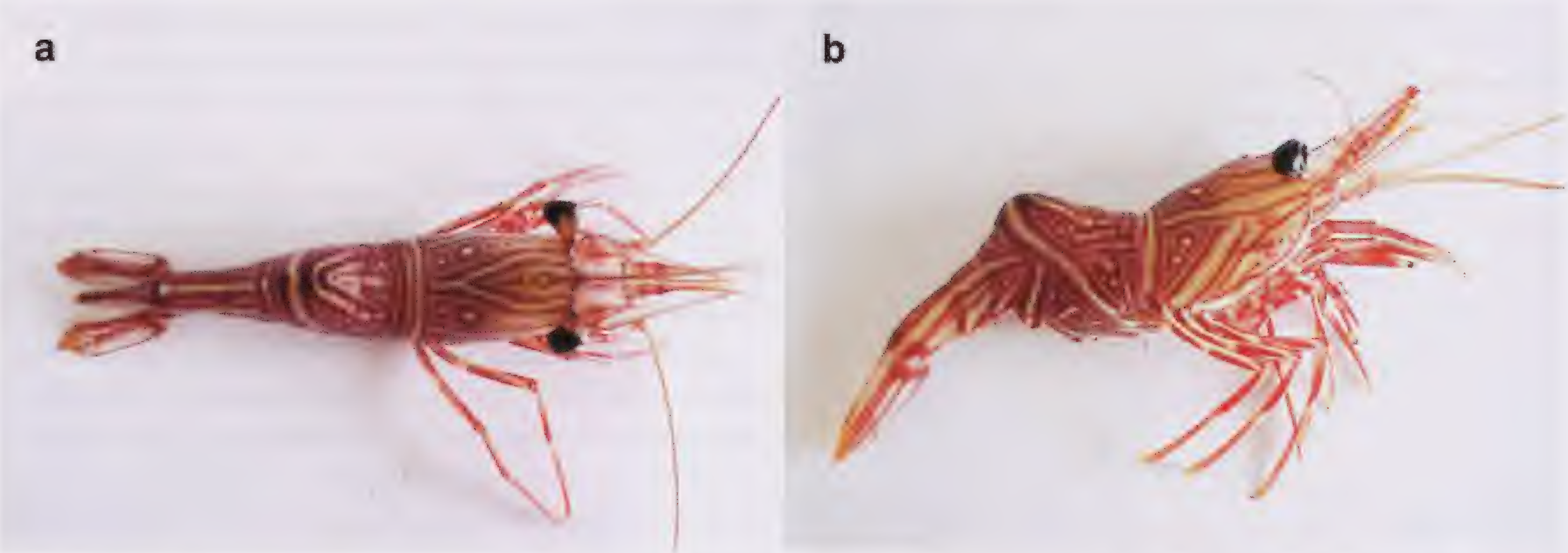

Fig. 1: *Rhynchocinetes durbanensis* Gordon, 1936. Total length 6.6 cm, carapace length 1.5 cm, MBRC/ZSI M_1-57. (a) female, dorsal view; b) female, lateral view

Collections of Marine Biological Regional Centre (MBRC), Zoological Survey of India (ZSI), Chennai, Tamil Nadu.

Identification up to species level was done using standard literature (Gordon 1936; Okuno and Takeda 1992). Size is expressed as total length (tl in mm) from the tip of the rostrum to the posterior margin of the telson, and carapace length (cl in mm) from the posterior orbital margin to the posterior margin of the carapace.

***Rhynchocinetes durbanensis* Gordon, 1936 (Fig. 1)**

(Order: Decapoda Latreille, 1802; Infra order: Caridea Dana, 1852; Family: Rhynchocinetidae Ortmann, 1890; Genus: *Rhynchocinetes* Milne Edwards, 1837)

Common names: Camel shrimp, Dancing shrimp, Hinge-beak shrimp, Candy shrimp.

Five individuals (2 males and 3 females) (total length: 6.2–6.6 cm, carapace length: 1.1–1.5 cm) collected near the rocks at a depth of 2–3 m, from Tuticorin coast, Tamil Nadu, 8° 50' 12.59" N; 78° 14' 08.85" E, 16.i.2013, MBRC/ZSI M_1-57.

Body slender with humped abdomen. Rostrum with nine teeth on the upper margin and 16 teeth on lower margin. Carapace with Y-shaped white mark on each side on the dorsal surface. Outer margin of antennular peduncle slightly rounded, antennules with distal spine; third maxillipeds are elongated in males with spines near apex of ultimate segment. Carapace bearing two teeth in midline posterior to rostral juncture and sharp supra-orbital spine present. Telson with three pairs of dorsolateral as well as posterior spines. First pair of pereiopods with larger chela and shorter dactylus with absence of setae, appendix interna broad distally and longer than appendix masculina. Colour of body covered with vivid red irregular lines, white spots or lines in interspaces of each red line.

Distribution: This species has a circum-tropical distribution throughout the Indo-Pacific, but has been recorded only from South Africa, Ryukus, Philippines, and Indonesia (Chace 1997). In India, it was reported from Netrani Island, Karnataka coast (Dinesh Babu and Zacharia 2007; Zacharia *et al.* 2008), and it has now been recorded by us from Tuticorin, Tamil Nadu.

Rhynchocinetes durbanensis is readily separated from the other species of the same group by having three equidistant teeth on proximal to median parts of the rostral upper margin (Okuno and Takeda 1992). Presence of Y-shaped markings on the dorsal surface of the carapace is distinct in *R. durbanensis*, compared to its similar species *R. uritai*, *R. durbanensis* is also distinguished from the other genus *Cinetorhynchus hendersoni* by the presence of three teeth on carapace behind rostral articulation; no supra-orbital spine; a tooth on either side of the fifth abdominal somite above the posterior edge of pleuron. Rostrum with two teeth on upper border and nine teeth on the lower border; carapace and abdomen feebly striate (Kemp 1925).

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11. *CLOSTERIUM TORTITAENIOIDES* COESEL – AN INTERESTING NEW ALGA TO THE ASIAN CONTINENT

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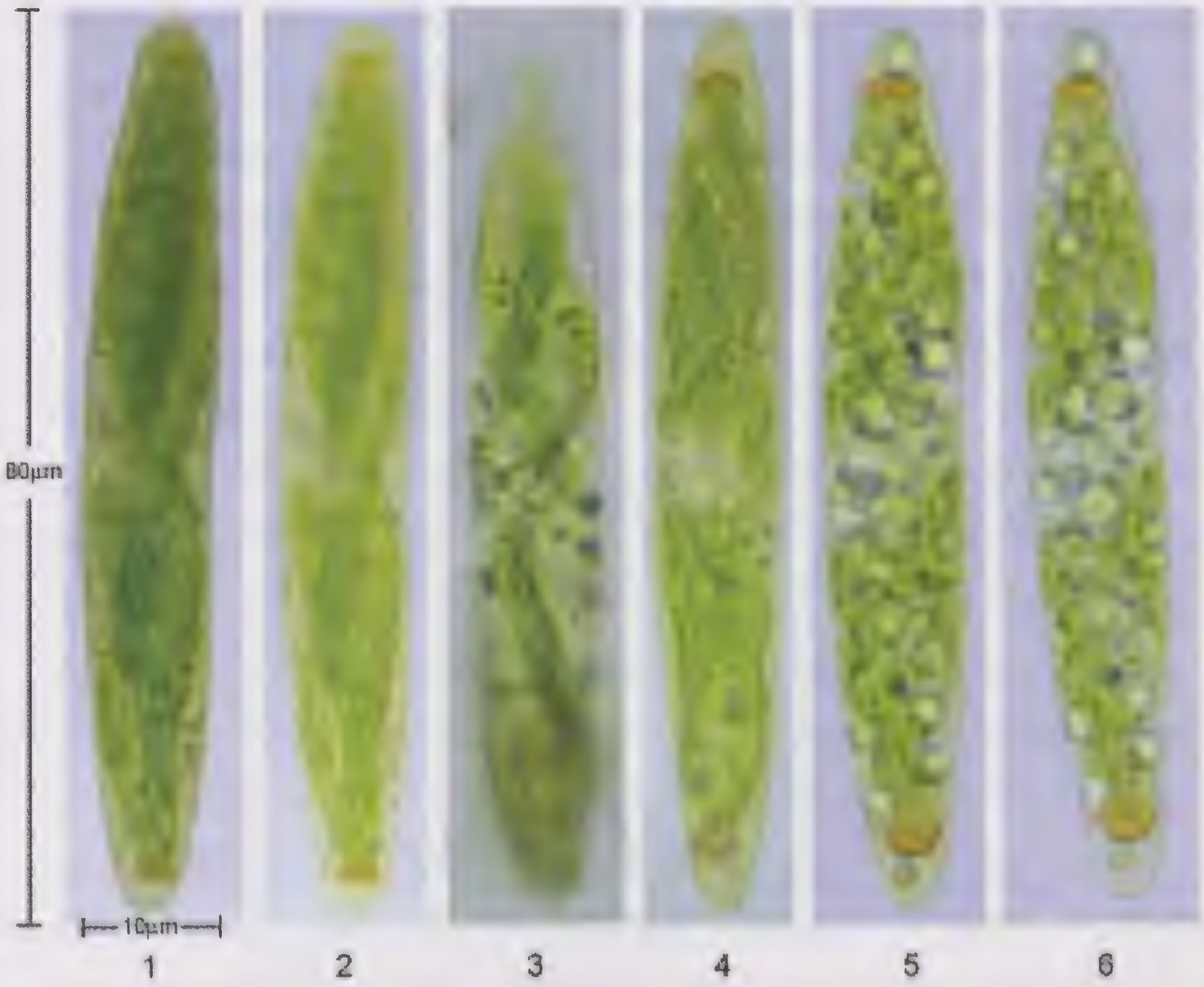
An extensive survey for algae of the Western Ghats (biodiversity hotspot) region of Idukki district, Kerala, India, was carried out from 2005 to 2010, during which a species of *Closterium*, namely *Closterium tortitaenioides* Coesel was recorded. It was recorded from a village pond (Collection site No. 243) [09° 50' 46.32" N; 77° 01' 07.72" E; pH 8.1; Temp. 22 °C]. This is the first report of the species from India and Asia.

This taxon had been described by Coesel (2002) as *Tortitaenia closterioides*. It was only recently described from a series of moorland pools near Oisterwijk, Netherlands, where it has been encountered abundantly in the last couple of years (Coesel 2002). It was possibly, in former years, erroneously treated as *Closterium cornu* or *Closterium navicula* (Ruzicka 1977). But recently in 2007, Coesel himself renamed it as *Closterium tortitaenioides*. In this manuscript, we describe the species based on the specimens collected during the survey.

Taxonomy: Cells singular, free, straight from centre



Figs 1–6: *Closterium tortitaenioides* Coesel. : 1–2 Vegetative cell, 3–4 Twisted chloroplast in the central region of the cell, 5–6 Orange-red coloration (carotenoid pigmentation) at either pole

to the ends gradually narrowed, at the ends bluntly rounded. Cells 7–9 µm wide, 65–80 µm long (Figs 1 and 2). Cell wall thin, hyaline, smooth. Chloroplast parietal, with a characteristic prominent twisting at the central region (Figs 3 and 4); chloroplast without pyrenoid, with prominent orange-red coloration (carotenoid pigmentation) at either poles (Figs 5 and 6); not reaching up to the ends of the cells. Protoplast with frequent oil droplets, usually prominent on either poles. Reproductive structures not observed.

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12. *BHESA ROBUSTA* (ROXB.) DING HOU, CELASTRACEAE: A NEW DISTRIBUTIONAL RECORD FROM TRIPURA, INDIA

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Introduction

Celastraceae R. Br. with nearly 100 genera and 1,300 species (Mabberley 2009) is a diverse plant family in tropical and temperate climatic zones. In India, the family is represented by 10 genera and 84 species (Ramamurthy 2000). Only two species of this family were known from Tripura: *Celastrus monospermus* Roxb. and *Maytenus hookeri* Loes (Deb 1981), till we recorded the occurrence of another species, *Bhesa robusta* (Roxb.) Ding Hou, from Trishna Wildlife Sanctuary (TWLS), Tripura. The APG III system of plant classification places genus *Bhesa* Buch.-Ham. ex Arn.along with the only other genus *Centroplacus* Pierre (formerly in Euphorbiaceae) in a new family, Centroplacaceae Doweld & Reveal (Chase and Reveal 2009). The genus *Bhesa* comprises seven accepted species (WCSP 2011), namely *B. archboldiana* (Merr. & Perry) Ding Hou, *B. ceylanica* (Arn. ex Thwaites) Ding Hou, *B. indica* (Bedd.) Ding Hou, *B. nitidissima* Kosterm., *B. paniculata* Arn., *B. robusta* (Roxb.) Ding Hou, and *B. sinica* (H.T. Chang & Liang) H.T. Chang & Liang.

Globally, *Bhesa robusta* is known to occur in Bangladesh, Bhutan (uncertain), Borneo, Cambodia, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Singapore, Thailand, and Vietnam (Ding Hou 1958, 1962; Mu Shu *et al.* 2008; Sosef *et al.* 1998; WCMC 1998). In India, it is recorded from the Andaman Islands, Arunachal Pradesh, Assam, and Meghalaya (WCMC 1998). A single tree of *Bhesa robusta* is known to occur in Hepu, SE Guangxi, China (Mu Shu *et al.* 2008).

In north-eastern India, U. Kanjilal initially collected *B. robusta* in 1913 from Nowgong and subsequently from Lakhimpur, Sibsagar, Darrang, Goalpara, and Tura. A. Das collected it from Cachar valley, Assam, and R.N. De from Dawki forest, Meghalaya (Table 1). We recorded its presence at two sites in Tripura: at the buffer zone of TWLS (23° 16' 38.30" N; 91° 22' 45.4" E) and the adjoining Golachiba (23° 22' 18.0" N; 91° 25' 27.9" E). These locations range between 35–62 m in altitude and experience tropical climate. The annual rainfall is 2,109 mm, and mean daily temperature ranges between 10.4 °C and 25.5 °C (Majumdar *et al.* 2012).

We recorded a total of five individuals: two from TWLS with a girth of 43 and 82 cm, and three from Golachiba with a girth of 33, 88, and 206 cm. The height of these trees was between 5–23 m. The identity of collected specimens was determined by a critical isotype examination (Cachar, Assam, 10.xi.1932; A. Das 5636) at the Botanical Survey of India, Shillong, and study of taxonomic descriptions in floras (Brandis 1906; Hooker 1875; Kanjilal *et al.* 1936; Mu Shu *et al.* 2008; Prain 1963; Ramamurthy 2000). The voucher specimens (Trishna Wildlife Sanctuary, Tripura, 21.ii.2010; K. Majumdar 0879) were deposited in the herbarium of the Department of Botany, Tripura University.

We have developed a detailed diagnostic description of *Bhesa robusta* from the collected specimens and from taxonomic literature (Brandis 1906; Hooker 1875; Kanjilal *et al.* 1936) as below:

Table 1: Inventory of the specimens of *Bhesa robusta* collected by different workers from north-eastern India

Sl #	BSI sheet number	Collection Date	Collection number	Collector's name	Locality
1	5634	31.xii.1913	4323	U. Kanjilal	Nowgong, Parokhowa
2	5630	11.ii.1914	3389	U. Kanjilal	Joypore RF, Lakhimpur
3	5629	25.iii.1914	6825	U. Kanjilal	Sibsagar
4	5627	10.i.1915	5367	U. Kanjilal	Darrang, Cherduar RF
5	5625	06.iii.1915	5247	U. Kanjilal	Tura Forest, Garo Hills
6	5621	20.i.1919	7472	U. Kanjilal	Goalpara
7	5636	10.xi.1932	10584	A. Das	Cachar
8	5647	28.vii.1939	18442	R. N. De	Dawki Forest
9	5619	26.ix.1939	19038	R. N. De	Dawki Forest
10	This study	21.ii. 2010	0879	K. Majumdar	Tripura

(Source: Botanical Survey of India, Shillong)

Bhesa robusta (Roxb.) Ding Hou in Blumea, Suppl. 4: 152. 1958; Fl. Jowai 1: 129. 1981. *Celastrus robustus* Roxb. in Fl. Ind. 1: 626–627. 1824. *Kurrimia calophylla* Wall. in Wall. Cat. 4335. 1828. *Kurrimia paniculata* Wall. in Wall. Cat. 4336. 1828. *Kurrimia pulcherrima* Wall. in Wall. Cat. 4334. 1828; Lawson in Fl. Brit. Ind. 1: 622. 1875; non. Wall. in *J. Bot. Suppl.* 22. 1924; Lawson in Fl. Ass. 1: 270. 1936. *B. moja* Ham. ex Arn. in Ham. mss.; Ed. Phil. Jour. 16: 315. 1834. *Nothocnestis sumatrana* Miq. in Fl. Ind. Bat. Suppl. 1: 531. 1861. *Kurrimia robusta* (Roxb.) Kurz. in *J. Asiat. Soc. Bengal*, Pt 2, Nat. Hist. 34(2): 73. 1870. *K. maingayi* M.A. Lawson in Fl. Brit. India 1: 622. 1875. *K. sinica* Hung T. Chang & S. Ye Liang. in Acta Sci. Nat. Univ. Sunyatseni 1: 100. 1981.

Large evergreen tree up to 30 m tall; crown oval; bark smooth, brown inside and grey outside; petiole short, 1–2 cm; leaves alternate, sometimes subopposite; leaf blade elliptic, oblong-elliptic, narrowly ovate, 10–20 × 3–6 cm, glossy, base rounded or broadly attenuate, margin repand, apex acuminate or acute, lateral nerves 12–15 pairs, prominent abaxially; inflorescence raceme, axillary, shorter than leaves, peduncle rudimentary; flower small, red; calyx lobes broadly ovate to subrotundate, 1 × 2 mm, acuminate at apex; petals obovate-oblong, 2–3 × 1 mm, subrotund at apex; stamens 4, 2 mm long, attached beneath the outer margin of the disc; anthers deltoid, obtuse; ovary superior, subglobose, 2-celled with two ovules in each cell, base surrounded by puberulous 5-lobed nectary disc; style 2, filiform, free, basally with tufted hairs; stigma small, headed, pubescent; fruit capsule, narrowly ellipsoid to ovoid-oblong, 0.8–1.2 × 2.5–3.5 cm, with 2 vertical grooves, tapering to apex, beaked, glabrous, 1-celled, 2-valved, 1–2 seeded; seeds arillate, oblong, brown, shiny; aril fleshy, bright yellow or orange.

Flowering: November–January.

Fruiting: February–April.

Discussion

The habitat of *B. robusta* was dominated by *Dipterocarpus turbinatus* in association with *Artocarpus chama*, *Artocarpus lakoocha*, *Dillenia pentagyna*, *Careya arborea*, *Carallia brachiata*, *Gardenia resinifera*, *Schima wallichii*, and *Xantolis assamica*. It is also found interspersed in bamboo brakes (*Bambusa tulda*, *Bambusa balcooa*, and *Melocanna baccifera*). These habitats encompass the international border between the State of Tripura (India) and Bangladesh, and experience human disturbance. A large number of trees, including those of *B. robusta*, have been felled illicitly for timber, fuel-wood, and house construction, underlining the threat to the conservation of these habitats. Although *B. robusta* has been included in IUCN Red List of threatened plants with category LC (Least Concern), its local extinction is inevitable in the face of unabated felling and habitat loss.

Remarks

B. robusta was found to be an important feeding and nesting habitat for the Common Hill-Myna, *Gracula religiosa* L. (Family Sturnidae). A pair was observed nesting and feeding on its ripe fruits. We also observed it dispersing seeds after consuming the fleshy aril. Hence, the interaction between *B. robusta* and Hill-Myna is mutually beneficial. The ability of the Hill-Myna to imitate speech makes it a favourite cage bird. Hence, sizeable marketed quantities are taken from the wild, depleting their populations greatly (Archawaranon 2003). Due to the heavy trade, Hill-Myna was included in CITES Appendix III in 1992 and was subsequently included in Appendix II in 1997 (UNEP-WCMC 2011).

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13. *DOPATRIUM JUNCEUM* (ROXB.) BUCH.-HAM. EX BENTH. – A NEW RECORD FOR THE FLORA OF TRIPURA, INDIA

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The genus *Dopatrium* belongs to the tribe Gratioleae of family Plantaginaceae. It is represented by 14 species in the world, of which four occur in Asia, namely *Dopatrium junceum* (Roxb.) Buch.-Ham.ex Benth., *D. acutifolium* Bonati, *D. nudicaule* Benth., and *D. lobeliodes* Benth. (Fischer 1997). In India, it is represented by three species, namely *Dopatrium junceum* (Roxb.) Buch.-Ham. ex Benth., *D. nudicaule* Benth., and *D. lobeliodes* Benth. (Cook 1996).

During field survey in different regions of Tripura, we collected some specimens of this genus from the West district of Tripura. On critical examination and consultation with a herbarium (CAL), the specimens were identified as *Dopatrium junceum*. A perusal of relevant literature (Bhowmik *et al.* 2008; Cook 1996; Deb 1981–83; Prain 1996) revealed that the species is not hitherto known from Tripura.

***Dopatrium junceum* (Roxb.) Buch.–Ham. ex Benth.** *Gratiola juncea* Roxburgh, Pl. Coromandel 2: 16. 1798. *Dopatrium junceum* Ham. Benth., Scroph. Ind. 31.1846; Hook.f., Fl. Brit. Ind. 4.274.1874; *Dopatrium junceum* Ham. Prain Beng. Pl. 2. 765. 1903; Cook, C.D.K. Aquatic and Wetland Plants of India. 342.1996.

Annual, slender, glabrous herb; Leaves few, opposite, succulent, oblong-ovate or elliptic-ovate, lowest ones 2–3 cm long, 0.3–0.6 cm wide, upper ones scale-like, 0.3–0.5 cm long, sessile; Flowers small axillary, solitary; Bracteoles absent; Pedicels capillary, 10–25 mm long; Calyx campanulate, calyx 1–1.5 mm long; lobes 5, apex obtuse; Corolla pale purple, 3 mm long. lower lip lobes spreading, flat; upper lip erect, short; Stamens glabrous, filament 0.5 mm, anthers equal, 0.5 m long, bearded; Staminodes 2, small, inserted on anterior side; Style short, stigma 2-lamellate, ovary 2-loculed, ovules numerous in each locules; Capsules globose to ovoid, 2-lobed, 2–3 mm long; Seeds ovoid, 0.2 mm long, numerous, transversely and laterally ribbed.

Habitat: Paddy fields.

Local Occurrence: Occasionally reported from paddy fields.

Specimens Examined: Bhowmik & Datta 256, Anandanagar, 11.viii.2008; Datta and Bhowmik, Nagichara, 458, 18.ix.2009.

Phenology: August–September.

Distribution: GLOBAL: Africa, Australia, China, Hong Kong, India, Japan, Java, Korea, Nepal, Philippines, Russia, Sri Lanka, Taiwan, Thailand, Vietnam.

INDIA: Andaman and Nicobar, Assam, Gujarat, Goa, Jammu & Kashmir, Kerala, Karnataka, Madhya Pradesh, Rajasthan, Tamil Nadu, West Bengal.

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14. RANGE EXTENSION FOR CRITICALLY ENDANGERED PLANT, *CRINUM WOODROWII* BAKER

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Crinum woodrowii Baker, an IUCN red listed plant species (Punekar *et al*. 2004) was presumed to be restricted to the Mahabaleshwar region (Bachulkar 1993; Punekar *et al*. 2001) of Maharashtra. We recorded the species in June 2012 on the banks of Vaitarna river in Vihigaon, Thane district (19º 42' 57'' N; 73º 28' 39'' E), after the first few showers of the monsoon. The plants (about 50 in number) were recorded in the forest, growing in association with *Curculigo orchioides* Gaertn., *Chlorophytum tuberosum* Baker, *Pancratium* sp., *Tectona grandis* L.f., and *Terminalia tomentosa* W.&A. This new location is the second known locality for this critically endangered plant species, other than Mahabaleshwar. However, this population is in danger of being lost due to impacts from the Middle Vaitarna Dam that is coming up in the area, which will submerge the forest where these plants were recorded.

A detailed description of the species is given below for its easy identification:

C. woodrowii Baker is a tall herb which grows from globose bulbs. The bulbs are 8.6–16.2 cm in diameter, globose–spheroidal, outer tunics brown, membranous. The plant bears leaves and flowers at the same time, which is typical phenomenon for bulbous and rhizomatous plants. There are 8–17 sword-shaped hairless leaves, which are flat, bright green, with a sharply-pointed apex and have a white waxy texture. The leaves are 45.5–80 x 4.5–14 cm long. The leaf sheaths form a pseudostem. A single scape (leafless flower stalk), arising from the bulb outside the tuft of leaves, is stout and 53.5–82.5 cm x 1–3 cm tall. The scape was faintly channelled. Spathe valves (involucral bracts) two, opposite, 8.7–10 cm x 2.7–3.9 cm, deltoid, obtuse or acute at apex, margin inflexed, often green, purple tinged, nervate, coriaceous.10–20 fragrant flowers are borne in an umbel.

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CONTENTS

EDITORIAL ... 93

RESPONSE TO THE REVIEW OF EXOTIC ALIENS FROM ROMILA THAPAR, YUSUF ANSARI, AND VALMIK THAPAR
Valmik Thapar, Romila Thapar and Yusuf Ansari ... 95

EXOTIC ALIENS – LION AND CHEETAH IN INDIA: A REJOINDER TO AUTHORS' RESPONSE TO OUR REVIEW
M.K. Ranjitsinh and Divyabhanusinh ... 105

THE "EXOTIC ALIENS" CONTROVERSY: A VIEW FROM AFAR
Stephen J. O'Brien ... 108

THE MAMMALS OF SRIHARIKOTA ISLAND, SOUTHERN INDIA, WITH INSIGHTS INTO THEIR STATUS, POPULATION, AND DISTRIBUTION
Ranjit Manakadan, S. Sivakumar, Patrick David and B. Senthil Murugan ... 114

DIVERSITY AND ABUNDANCE OF RODENTS IN THE SEMI-ARID LANDSCAPE OF SARISKA TIGER RESERVE, WESTERN INDIA
Shilpi Gupta, Krishnendu Mondal, K. Sankar and Qamar Qureshi ... 122

THE STATUS OF THE GANGES RIVER DOLPHIN *PLATANISTA GANGETICA GANGETICA* IN THE RIVER BARAK, ASSAM, INDIA
Th. P. Singha, B.K. Dutta and S.P. Biswas ... 129

PTERIDOPHYTIC DIVERSITY OF BAROT, MANDI DISTRICT, HIMACHAL PRADESH, INDIA
Alka Kumari, Brij Lal and Om Prakash ... 135

TERRITORIALITY IN KERALA LAUGHINGTHRUSH *STROPHOCINCLA FAIRBANKI MERIDIONALIS*
Vivek Chandran A. and Praveen J. ... 142

REVIEWS ... 147

MISCELLANEOUS NOTES ... 149

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VOLUME 110(3): DECEMBER 2013

CONTENTS

EDITORIAL 171

THE BIRDS OF SANGLI DISTRICT, MAHARASHTRA, INDIA
V.B. Tuljapurkar, V.R. Bhagwat and G.A. Jathar 172

NOTES ON THE NEWLY DISCOVERED POPULATION OF SIND JERDON'S BABBLER *CHRYSOMMA ALTIROSTRE SCINDICUM* IN HARIKE WILDLIFE SANCTUARY, PUNJAB, INDIA
Saurabh Sawant and M. Sudhagar (IFS) 187

A PRELIMINARY OVERVIEW OF THE SUBSPECIES OF RED FOX AND TIBETAN SAND FOX IN THE HIMALAYA, INDIA
Aishwarya Maheshwari, Neha Midha, Ambica Paliwal, Basant Kumar Sharma, Partha Sarathi Ghose, Priyadarshinee Shreshtha and Srushti Paranjpe 193

DORYLAIMID AND TYLENCHID NEMATODES ASSOCIATED WITH BANANA PLANTATIONS IN PASCHIM MEDINIPUR DISTRICT, WEST BENGAL, INDIA
Viswa Venkat Gantait, Amalendu Chatterjee and Tanmay Bhattacharya 197

SIGNIFICANCE OF PHALLIC COMPLEX IN THE CLASSIFICATION OF INDIAN PYRGOMORPHIDAE (ORTHOPTERA: PYRGOMORPHOIDEA)
Hirdesh Kumar, Mohd. Kamil Usmani, Uzma Rafi and Reenu Kumari 204

THE TRADE, TRAPPING, AND UTILIZATION OF LORISES IN INDIA
Abrar Ahmed 210

OBITUARY

T.J. ROBERTS (1924–2013) 214

ZAFAR FUTEHALLY (1920–2013) 215

REVIEWS

1. BUTTERFLIES OF THE GARO HILLS
Reviewed by Peter Smetacek 216

2. HIMALAYA: MOUNTAIN OF LIFE
Reviewed by Asad R. Rahmani 217

3. FAUNAL HERITAGE OF RAJASTHAN, INDIA
Reviewed by Ranjit Manakadan 218

SMITHSONIAN
SEP 3 0 2014
LIBRARIES

MISCELLANEOUS NOTES

MAMMALS

1. First record of melanistic Indian Wolf *Canis lupus pallipes* from the Indian subcontinent
Amolkumar S. Lokhande and Sameer B. Bajaru 220

BIRDS

2. First breeding record of the Lesser Adjutant *Leptoptilus javanicus* (Horsfield, 1821) from Bokaro district, Jharkhand, India
Mithilesh Dutt Dwivedi, Satya Prakash, Anil Kumar Mishra, Vibhu Prakash, Gurudutta Dwivedi and Mohammad Raziuddin 222

3. First record of Lesser White-fronted Goose *Anser erythropus* from Gujarat, India
Asif N. Khan 224

4. Sighting of Baillon's Crake *Porzana pusilla* near Chennai, India
Jency Samuel 224

5. Photographic record of the Buff-breasted Sandpiper *Tryngites subruficollis* in Kerala – fifth record from the Indian subcontinent
P.C. Rajeevan and Jayan Thomas 225

6. Use of Red-rumped Swallow *Cecropis daurica* nest by Yellow-throated Sparrow *Gymnoris xanthocollis*
Satish Kumar Sharma and Vijay Kumar Koli 226

7. Record of a Black-legged Kittiwake *Rissa tridactyla* in south-eastern Rajasthan, India
Jim Lawrence 227

FISH

8. *Pangasianodon hypophthalmus* (Sauvage, 1878) – an alien catfish in Muvattupuzha river, Kerala, India
K.V. Zeena and K.S. Jameela Beevi 228

INSECTS

9. *Ypthima kedarnathensis* Singh – new synonym of *Ypthima sakra* Moore (Nymphalidae: Satyrinae) from Garhwal Himalaya, India
Narender Sharma 230

BOTANY

10. *Cucumis dipsaceus* Ehrenb. ex Spach (Cucurbitaceae): a new record for Karnataka, India
Shrikant P. Sutar, Tushar M. Dixit, S.R. Yadav and K.V. Bhat 233

11. *Spigelia anthelmia* L. (Spigeliaceae): new record to the flora of Gujarat state, India
Rinku J. Desai and Vinay M. Raole 234
12. *Luisia trichorrhiza* (Hook.) Blume – an addition to the Orchid flora of Maharashtra, India
G.D. Muratkar, R.S. Govekar and M.M. Sardesai 236
13. *Dipcadi montanum* (Dalzell) Baker – an addition to the flora of Kerala, India
Sojan Jose, V. Suresh, R. Prakash Kumar and P.V. Madhusoodanan 237
14. Absence of *Ulva reticulata* Forsskal from the coast of Goa, India
N. Pereira and M.R. Almeida 238

Cover Photograph: Cricket *Schizodactylus monstrosus* By Dharmendra Khandal

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Editorial

The *Journal of the Bombay Natural History Society* was first published in 1886, three years after the establishment of BNHS. The objective of this first publication of the Society was to collate and disseminate information on natural history of the Indian subcontinent and beyond. The *Journal* has been printed uninterrupted (with some delays during the World Wars due to paper shortage) since. In its journey of over a century the *JBNHS* changed with changing times and achieved a number of milestones. In today's age of information shared worldwide, with speed appropriate to the information highway, it is time for one more change.

We live in an era of digitization; the internet has changed our habits and also our expectations. Today we want timely availability and easy access to information. *JBNHS* recently widened the scope (political boundaries for papers published in the *JBNHS* are no longer limited to the Subcontinent) of its publication; it now aims to increase its visibility. The first step in this direction is to go digital. Therefore, from 2014, besides its print version *JBNHS* will also be available online.

The groundwork for this change has been initiated, but much more needs to be done. In the first phase of this process, we shall make the peer review process of articles submitted to the *JBNHS* completely online. The *JBNHS* website will have all operational tasks such as manuscript submission, peer review, archiving, and indexing. Both authors and reviewers will now be able to track online their submissions to the *JBNHS*.

All articles published in the *JBNHS* will now have a digital object identifier (DOI), i.e. a unique digital identification code which will help identify an article. Simply put, the DOI for a document remains fixed over the lifetime of the document, whereas its location and other metadata may change. Referring to an online document by its DOI is simpler than referring to it by its URL, as the URL may change, but the DOI will never.

What does not change? The *JBNHS* will remain a subscribed journal. However, subscribers will now have a choice of buying either the print or online version, or both. Alternatively, there will also be facility to purchase a single paper.

We hope that the online version of the *JBNHS* will expand the outreach of the journal and meet our readers' present and future needs.

Editors'

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THE BIRDS OF SANGLI DISTRICT, MAHARASHTRA, INDIA

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Surveys were undertaken over a period of 20 years to document the birds of Sangli district, which included 430 field visits from 1985. The surveys resulted in a checklist of 297 bird species for the district, which included 191 resident, 77 winter migrants, 9 local migrants, 4 breeding migrant, 3 vagrant bird species, 3 resident as well as migrant, 1 passage migrant and status of 9 could not be determined. There were 5 threatened and 19 endemic species amongst all the avifauna. The information obtained on the birds of the district from this survey is compared with records of Butler (1881).

Key words: Sangli district, birds, Deccan Plateau, Western Ghats

INTRODUCTION

Sangli is one of the southernmost districts of Maharashtra in peninsular India. Though botanists and birdwatchers have documented the flora and salient features of the birdlife of the district, much of this data remains unpublished or has not been summarised. In an endeavour to fill in this lacuna, we bring out this paper on the birds of the district, which is based on records maintained by us during surveys and incidental field visits since the last two decades. The records of species obtained are compared with old (Butler 1881) and recent records of birders from the area.

STUDY AREA

Location and Boundaries: Sangli district[1] (16° 43'–17° 38' N, 73° 41'–75° 41' E; 8,572 sq. km) shares the boundaries of following districts in Maharashtra and Karnataka: Satara in the north-west, Solapur in the north-east, Kolhapur in the south-west, Belgaum in the south, and Bijapur in the south-east. A part of the district includes a section of the Sahyadri (Western Ghats) range in the west, beyond which is Ratnagiri district of the Konkan. Till 1948, part of the present Sangli district came under the former princely states of Aundh, Jath, Sangli, Miraj, Kurundwad, and Wadi. A segment of it was in the old Satara district. In 1949, the area was reorganised and named as South Satara district with six talukas namely, Tasgaon, Khanapur, Shirala, Walwa, and the erstwhile princely states of Miraj and Jath. In 1960, it was renamed as Sangli district, with Sangli city as the district headquarters.

Terrain and Forests[2]: Sangli is bordered in the west by the ranges of the Western Ghats that reach a height of 1,044 m. The western slopes receive heavy rainfall, and hence, the forest is dense and covered with evergreens, which includes the Chandoli National Park (318 sq. km). The eastern slopes consist of a series of scattered hills, which has mixed deciduous, and dry mixed deciduous forests (Champion and Seth 1968). The forests in the central part of the district east of River Krishna are scrub forests and bush covering small hills. In the extreme east of the district, which falls under the Deccan Plateau, the landscape is 'barren' with scattered trees.

Drainages and Wetlands: The main rivers that traverse the district are Krishna, Warana, and Yerla. There are small rivers such as Agrani, Manganga, Korda, Bor, and Patna that join the main river systems of the district, but most of these (and the other seasonal streams) dry up in summer. River Warana originates in the Western Ghats near Prachitgad in Patan taluka of Satara district and flows through Shirala taluka to join River Krishna at Haripur near Sangli. A dam has been constructed on River Warana at Chandoli, the backwaters of which extend up to 30 km and form a huge lake called Vasant Sagar with a waterspread of 45 sq. km. Rajewadi tank (13.56 sq. km) was constructed in 1879 during the British Raj, with part of it falling in Satara district. Besides these waterbodies, there are others lakes at Banpuri, Lingnur, and Bhose.

Climate: Except for April and May, the climate is pleasant over the year with generally dry weather. The southwest monsoon commences in June and ends in September. There is a short spell of hot weather in October. The cold weather begins in November, which is followed by spring in February and March. Overall, the climate does not have extremes of cold and hot weather. The rainfall shows considerable discrepancy. In the west, the area of Chandoli Dam receives around 3,500 mm; the crest of Western Ghats gets even higher rainfall of 4,000–6,000 mm. As the clouds move eastwards, the rainfall gradually decreases. While Shirala taluka and surrounding areas receive around 1,016 mm, it is around 508 mm in the Tasgaon and Khanapur talukas. The twin cities of Sangli and Miraj receive around 457 mm; the Kavathemahankal and Jath talukas get even less rainfall, ranging from 254 to 381 mm.

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[1] Gazetteer of Sangli district - 1969a: Climate
[2] Gazetteer of Sangli district - 1969b: Forests

Land Use[3]: The human population of the district is 2,820,575 (District Socio-Economic Review of Sangli 2012), an increase of 9% in ten years from 2,583,524 (District Socio-Economic Review of Sangli 2012). The geographic area of the district (8,572 sq. km) can be broadly divided into cultivable land (5,950 sq. km), forests (450 sq. km), and barren uncultivable land (380 sq. km), besides others. Sugarcane, rice, pulses (moong, masoor, and cowpea), sorghum, pearl millet, cotton, and tobacco are the major crops in the area. Grapes and pomegranate are the important fruit crops grown in the region. The livestock density in the district is 125.40/ sq. km, which includes cattle, sheep, and goats, and there is hardly any control on grazing.

Historical records of the avifauna of the district

Capt. E.A. Butler published a paper 'Birds of the Deccan and South Mahratta Country' in *Stray Feathers* (Butler 1881). The region covered (16° to 19° N; 73° to 76° E) encompasses the areas of Satara, Ahmednagar, Bombay (Mumbai), Poona (Pune), Solapur, Ratnagiri, Sawantwadi, and Khandala of present day Maharashtra, and some areas of Goa and northern Karnataka. There is no mention of Sangli as such in his paper, even though it was covered, as this district came into existence in 1960. Hence, we treat Butler's statement "occurs throughout the region" for a species to denote that it also occurs in Sangli district. Butler also states that some of the districts were not covered, especially those in the Western Ghats areas, and hence, there is a high possibility of him having missed some of the species that we recorded in this region due to less coverage.

METHODOLOGY

The data was collected by various birdwatchers, some working singly and others in pairs or groups. The specific sites surveyed and the field visits undertaken are described below:

Eastern part of Sangli district: The eastern part of Sangli district mainly comprises two talukas – Kavathemahankal and Jath. The rainfall is scanty and agricultural development is less compared to the western part of the district. The tree cover is poor, and there are vast areas of open scrub interspersed with grasslands. Tuljapurkar and Bhagwat surveyed this area from 1984 to 2001. A range of low elevations called Dandoba Hills Forest Preserve is located about 20 km from Miraj on the road to Pandharpur. The tree cover is fair on the slopes, but the top has only scattered bushes. There is not much human movement and hence disturbance is less. The vegetation surrounding the hills and stretching further to Kavathemahankal and Jath talukas is mainly open scrub with the exception of a few pockets of cultivation. Tuljapurkar visited the areas up to Dandoba Hills for studying and photographing ground-nesting birds from 1984 to 1996. Bhagwat also covered this area, and also visited the nearby villages of Savali, Tanang, Siddhewadi, Bhose, Alkud, and some others from 1991 to 2001. The barren uncultivated land in Kavathemahankal and Jath talukas were not covered.

River Krishna at Mhaisal village: Mhaisal is a village on the banks of River Krishna, south of Miraj near the border of Karnataka. There is a low level bund on the river which supports a small reservoir of water all year round. Deepak Shinde, a resident of Mhaisal, has been keeping records of his observations and photographs of birds of this area (Shinde 2008a,b). The images posted on his blog have been of great help in establishing the presence of certain bird species in this area.

Waste Disposal Site, Miraj: Built in 1968, the Waste Disposal Site (WDS) for Miraj town is located about 5 km on the Arag road. It covers an area of 4.4 ha that includes eight oxidation tanks of 0.4 ha each. A large section of the site is used to dump solid waste. Two of the authors covered this site from 1985 to 1995 (Tuljapurkar and Bhagwat 2007).

Sagareshwar Wildlife Sanctuary: Sagareshwar Wildlife Sanctuary (10 sq. km; 900 m above msl) is situated about 50 km north of Sangli. It consists of deciduous forest and grasslands in an undulating terrain; the annual rainfall averages 400 mm. In the early 1990s, one of the authors (Tuljapurkar 1992) had visited the sanctuary frequently, documenting the habitat, flora, birds, and mammals. Sharad Apte made a more detailed study of the avifauna in the sanctuary, visiting it on 50 occasions during three years from August 1997–October 2000.

Dabhai Kuran: Atpadi is a small town situated about 100 km north of Miraj. At the outskirts of Atpadi (6 km), there is a reservoir that serves as a source of water to the town. The reservoir is surrounded by a large expanse of grassland. The grasslands to the south-west of the wetland is reserved grassland, Dabhai Kuran (11.43 sq. km), and is protected by the Forest Department with restrictions on cattle grazing. There are a few scattered bushes and trees, namely *Ziziphus*, *Acacia*, *Cassia,* agave, and neem. The annual rainfall is about 470 mm. Bhagwat visited the grassland on eight occasions over a five year period from March 1992 to mid February 1997. Sharad Apte visited Dabhai Kuran on several occasions from 1990 to 1994.

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[3] District Socio-Economic Review of Sangli (2012)

Chandoli National Park: Chandoli National Park is situated in the western part of the district and includes part of Sahyadri range. River Warana originates in the Chandoli area. A dam was constructed on this river and the huge expanse of the reservoir prohibits easy access to the Park, and hence, disturbance to wildlife is minimal. People who earlier lived in villages within the forests were later relocated out of the sanctuary.

Members of Green Guards, an NGO from Kolhapur, have visited Chandoli National Park on several occasions and have documented the avifauna. From March 1995 to November 2007, these birdwatchers visited the area on 35 occasions in groups, staying for various periods of time. During these visits, the sightings of birds were recorded and a comprehensive list was prepared – which has not been published. A large part of the Park was covered, except for sites that were difficult to access. The sites visited by Green Guards (with the number of visits for each site given within parenthesis) are: Lotiv (1), Rundiv (7), Gave (2), Nivale (8), Nivale sada (1), Kandhar Doh (4), Zolambi (19), Zolambi sada (2), Ram-nadee (4), Siddheshwar (4), Ambole (3), Ghotane (4), Prachitgad (4), Kundi (1), Chandel (10), Dhakale (10), Udgiri (1), Khundalapur (1), Khundalapur dara (1), Bhogiv (5), Jinti (1), Jawali (4), Kotharwadi (4), Tanali (1), Durgawadi (1), Takale (6), Karambali dara (6), Chandoli khurd (3), Vetti (5), Valmik sada (1), Sonarli (1), Aloli (1), Vagh-kada (1) and Pandhar pani (1).

Other information available on the birds of Chandoli are from Jathar and Kulkarni (2005), who visited the Park in March 2005 to photo-document the avifauna, and Gole (1998), who visited the Park from December 1994 to April 1996. Prakash Gole's birding was confined to the eastern part of the hills, and he also commented on the inaccessibility of some sites.

RESULTS AND DISCUSSION

This study reports the occurrence of 297 bird species from Sangli district, comprising of 191 resident species, 77 winter migrants, 9 local migrants, 4 breeding migrants, 3 vagrants, 3 species that had populations that were resident and local migrants, 1 passage migrant (Table 1). The status of 9 bird species could not be determined. There is much diversity in the avifauna due to the assemblage of various habitats and transition zones. Sixty-seven species are associated with wetlands, 44 with grasslands, 95 with forests, and the rest (91 species) are habitat generalist. Other than Table 1, which lists all the species found in the district, given below are accounts of some species, which are threatened or/ and endemic species, and of the heronries and roosts recorded in the area.

Threatened Species[4]

Five Threatened species were recorded, and of these, three are Critically Endangered, and one each is Endangered or Vulnerable. Seven Near Threatened species were also recorded (Table 1).

Long-billed Vulture *Gyps indicus*: The Long-billed Vulture was reported as "not uncommon in districts where there are high cliffs to which it resorts to breed" (Butler 1881). The species was recorded at Chandoli National Park, where it was found on a western cliff till 1995, but sightings are now rare. The Long-billed Vulture was sighted in flight near Prachitgad area in 2005 and 2006 by Green Guards, and locals reported the presence of nests in the 1990s.

White-rumped Vulture *Gyps bengalensis*: The White-rumped Vulture was once abundant in the district. Butler (1881) recorded it as a commonly sighted permanent resident throughout the area. The species was occasionally seen in Sangli district two decades back; however in subsequent years its numbers have declined rapidly and the sightings are now scarce. Our observations are mainly around Miraj. Five birds were seen at Miraj feeding on the carcass of a horse on the Miraj-Sangli road on May 1, 1985. A flock of more than 25 birds was seen feeding on a carcass on the Miraj-Jaysingpur road (Bhagwat 2002). The sightings at WDS were more common. About 50 vultures were observed in March 1994 (Tuljapurkar and Bhagwat 2007); a pair was observed feeding on a carcass on September 29, 1993, and a flock of more than 20 birds was seen perched on coconut trees, all three sightings at WDS.

Egyptian Vulture *Neophron percnopterus*: Butler (1881) reported that the species was a common resident throughout the region. The species was only recorded at Chandoli National Park by Green Guards in 2007, however they did not record the number of individuals observed.

Great Indian Bustard *Ardeotis nigriceps*: Butler (1881) mentioned that the Great Indian Bustard (GIB) was probably a resident species and usually observed in the plains, and was common around Miraj (Sangli district). He also mentions its presence near Solapur, Ahmednagar, and Pune. We did not obtain records of the species during our surveys. As the eastern part of Sangli district appears to be suitable habitat for the GIB, additional efforts were made to obtain information on the last sightings of the species in the Jath area. Enquiries made at a few places revealed that the species occurred in the past. An octogenarian school teacher mentioned seeing birds near

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[4] BirdLife International (2014)

Table 1: Checklist of the birds of Sangli district

Sr. No	Species	Status	Status IUCN	Endemic to India	Occurrence	Location
1.	Little Grebe *Tachybaptus ruficollis*	R	LC	-	Common	WDS, DK, CNP
2.	Little Cormorant *Phalacrocorax niger*	R	LC	-	Common	DK, CNP, TR
3.	Grey Heron *Ardea cinerea*	M	LC	-	Common	WDS, DK, MHL, TR
4.	Purple Heron *Ardea purpurea*	R	LC	-	Occasional	SMK, CNP
5.	Indian Pond Heron *Ardeola grayii*	R	LC	-	Common	WDS, DK, TR, CNP, MHL
6.	Eastern Cattle-Egret *Bubulcus coromandus*	R	LC	-	Common	WDS, DK, CNP, MHL, SMK, TR
7.	Great Egret *Egretta alba*	M	LC	-	Common	DK, SMK, TR
8.	Intermediate Egret *Egretta intermedia*	M	LC	-	Common	WDS, DK
9.	Little Egret *Egretta garzetta*	R	LC	-	Common	WDS, DK, CNP, MHL, SMK
10.	Western Reef-Heron *Egretta gularis*	V	LC	-	Occasional	SMK
11.	Black-crowned Night-Heron *Nycticorax nycticorax*	R	LC	-	Common	DK, SMK, CNP
12.	Chestnut Bittern *Ixobrychus cinnamomeus*	NK	LC	-	Uncommon	CNP
13.	Painted Stork *Mycteria leucocephala*	LM	NT	-	Common	DK
14.	Asian Openbill *Anastomus oscitans*	LM	LC	-	Rare	DK
15.	White-necked Stork *Ciconia episcopus*	R	LC	-	Common	DK, SMK, MHL
16.	European White Stork *Ciconia ciconia*	M	LC	-	Rare	TR
17.	Black-headed Ibis *Threskiornis melanocephala*	LM	NT	-	Occasional	WDS, DK, MHL, SMK
18.	Indian Black Ibis *Pseudibis papillosa*	R	LC	-	Common	WDS, DK, MHL, SMK, TR
19.	Glossy Ibis *Plegadis falcinellus*	R	LC	-	Occasional	DK
20.	Eurasian Spoonbill *Platalea leucorodia*	LM	LC	-	Common	DK, MHL, SMK, TR
21.	Greater Flamingo *Phoenicopterus roseus*	M	LC	-	Occasional	DK, TR
22.	Bar-headed Goose *Anser indicus*	M	LC	-	Common	DK
23.	Lesser Whistling-Duck *Dendrocygna javanica*	M	LC	-	Rare	WDS, DK, TR
24.	Ruddy Shelduck *Tadorna ferruginea*	M	LC	-	Common	DK, TR
25.	Northern Pintail *Anas acuta*	M	LC	-	Common	WDS, DK, TR
26.	Common Teal *Anas crecca*	M	LC	-	Common	WDS, DK, SMK, TR
27.	Indian Spot-billed Duck *Anas poecilorhyncha*	R	LC	-	Common	WDS, DK,MHL, SMK
28.	Eurasian Wigeon *Anas penelope*	M	LC	-	Common	DK
29.	Garganey *Anas querquedula*	M	LC	-	Common	WDS, SMK
30.	Northern Shoveller *Anas clypeata*	M	LC	-	Occasional	DK, SMK
31.	Common Pochard *Aythya ferina*	M	LC	-	Common	DK

Table 1: Checklist of the birds of Sangli district (*contd.*)

Sr. No	Species	Status	Status IUCN	Endemic to India	Occurrence	Location
32.	Tufted Duck *Aythya fuligula*	M	LC	-	Rare	DK
33.	Comb Duck *Sarkidiornis melanotos*	M	LC	-	Rare	SMK, TR
34.	Black-winged Kite *Elanus caeruleus*	R	LC	-	Occasional	WDS, SGW, DK, CNP
35.	Oriental Honey-Buzzard *Pernis ptilorhynchus*	NK	LC	-	Rare	CNP
36.	Black Kite *Milvus migrans*	R	LC	-	Common	WDS, SMK, DK, CNP, MHL
37.	Brahminy Kite *Haliastur indus*	R	LC	-	Common	CNP, MHL, SMK
38.	Shikra *Accipiter badius*	R	LC	-	Common	SGW, SMK, CNP
39.	Crested Goshawk *Accipiter trivirgatus*	NK	LC	-	Rare	CNP
40.	Eurasian Sparrowhawk *Accipiter nisus*	M	LC	-	Occasional	DK, CNP
41.	Besra Sparrowhawk *Accipiter virgatus*	NK	LC	-	Occasional	CNP
42.	White-eyed Buzzard *Butastur teesa*	R	LC	-	Occasional	SGW, CNP
43.	Crested Hawk-Eagle *Spizaetus cirrhatus*	R	LC	-	Uncommon	CNP
44.	Bonelli's Eagle *Hieraaetus fasciatus*	R	LC	-	Uncommon	CNP
45.	Booted Eagle *Hieraaetus pennatus*	M	LC	-	Rare	Atpadi
46.	Tawny Eagle *Aquila rapax*	R	LC	-	Common	WDS, DK
47.	Steppe Eagle *Aquila nipalensis*	M	LC	-	Uncommon	CNP
48.	Black Eagle *Ictinaetus malayensis*	R	LC	-	Common	CNP
49.	White-bellied Sea-Eagle *Haliaeetus leucogaster*	V	LC	-	Common	CNP
50.	Long-billed Vulture *Gyps indicus*	R	CR	-	Rare	CNP
51.	White-backed Vulture *Gyps bengalensis*	R	CR	-	Rare	WDS, SMK
52.	Egyptian Vulture *Neophron percnopterus*	R	EN	-	Rare	CNP
53.	Pallid Harrier *Circus macrourus*	M	LC	-	Occasional	SGW, DK
54.	Montagu's Harrier *Circus pygargus*	M	LC	-	Occasional	SMK
55.	Western Marsh-Harrier *Circus aeruginosus*	M	LC	-	Common	WDS, DK, CNP, TR
56.	Short-toed Snake-Eagle *Circaetus gallicus*	R	LC	-	Uncommon	CNP
57.	Crested Serpent-Eagle *Spilornis cheela*	R	LC	-	Common	CNP
58.	Osprey *Pandion haliaetus*	M	LC	-	Rare	SMK, CNP
59.	Peregrine Falcon *Falco peregrinus*	R	LC	-	Rare	SGW, CNP
60.	Red-headed Falcon *Falco chicquera*	R	LC	-	Rare	SMK, CNP
61.	Lesser Kestrel *Falco naumanni*	M	LC	-	Rare	SMK
62.	Common Kestrel *Falco tinnunculus*	M	LC	-	Occasional	SGW, CNP

Table 1: Checklist of the birds of Sangli district (*contd.*)

Sr. No	Species	Status	Status IUCN	Endemic to India	Occurrence	Location
63.	Painted Francolin *Francolinus pictus*	R	LC	-	Common	WDS, SGW, DK, CNP
64.	Grey Francolin *Francolinus pondicerianus*	R	LC	-	Common	WDS, SGW, DK
65.	Rain Quail *Coturnix coromandelica*	R	LC	-	Common	SGW, DK, CNP
66.	Blue-breasted Quail *Coturnix chinensis*	NK	LC	-	Rare	CNP
67.	Jungle Bush-Quail *Perdicula asiatica*	R	LC	-	Common	SGW, DK, SMK, CNP
68.	Rock Bush-Quail *Perdicula argoondah*	R	LC	Endemic	Common	WDS
69.	Painted Bush-Quail *Perdicula erythrorhyncha*	R	LC	Endemic	Common	DK, CNP
70.	Red Spurfowl *Galloperdix spadicea*	R	LC	Endemic	Common	CNP
71.	Grey Junglefowl *Gallus sonneratii*	R	LC	Endemic	Common	CNP
72.	Indian Peafowl *Pavo cristatus*	R	LC	-	Common	SGW, DK, CNP, SMK, MHL
73.	Small Buttonquail *Turnix sylvaticus*	R	LC	-	Rare	CNP
74.	Barred Buttonquail *Turnix suscitator*	R	LC	-	Rare	SGW, DK, SMK
75.	Demoiselle Crane *Grus virgo*	M	LC	-	Common	DK
76.	White-breasted Waterhen *Amaurornis phoenicurus*	R	LC	-	Common	WDS, SGW, DK, CNP, MHL, SMK
77.	Common Moorhen *Gallinula chloropus*	LM	LC	-	Common	SGW, DK
78.	Purple Swamphen *Porphyrio porphyrio*	R	LC	-	Occasional	DK, SMK
79.	Eurasian Coot *Fulica atra*	M	LC	-	Common	DK, MHL
80.	Great Indian Bustard *Ardeotis nigriceps*	NK	CR	-	Not seen presently	Jath area
81.	Pheasant-tailed Jacana *Hydrophasianus chirurgus*	LM	LC	-	Uncommon	SMK, MHL
82.	Greater Painted-Snipe *Rostratula benghalensis*	V	LC	-	Rare	WDS, SMK
83.	Red-wattled Lapwing *Vanellus indicus*	R	LC	-	Common	WDS, SGW, DK, CNP, MHL, SMK
84.	Yellow-wattled Lapwing *Vanellus malabaricus*	R	LC	-	Common	WDS, SMK, DK
85.	Little Ringed Plover *Charadrius dubius*	M	LC	-	Common	WDS, DK, CNP, TR
86.	Kentish Plover *Charadrius alexandrinus*	M	LC	-	Common	WDS, DK
87.	Black-tailed Godwit *Limosa limosa*	M	NT	-	Common	DK
88.	Common Redshank *Tringa totanus*	M	LC	-	Common	WDS, DK, SMK
89.	Marsh Sandpiper *Tringa stagnatilis*	M	LC	-	Common	WDS, DK, CNP
90.	Common Greenshank *Tringa nebularia*	M	LC	-	Common	WDS, DK
91.	Green Sandpiper *Tringa ochropus*	M	LC	-	Common	WDS, DK, CNP, TR
92.	Wood Sandpiper *Tringa glareola*	M	LC	-	Common	WDS, DK, TR, CNP
93.	Common Sandpiper *Actitis hypoleucos*	M	LC	-	Common	WDS, DK, CNP, TR

Table 1: Checklist of the birds of Sangli district (*contd.*)

Sr. No	Species	Status	Status IUCN	Endemic to India	Occurrence	Location
94.	Common Snipe *Gallinago gallinago*	M	LC	-	Common	WDS, SGW, DK
95.	Little Stint *Calidris minuta*	M	LC	-	Common	WDS, DK
96.	Ruff *Philomachus pugnax*	M	LC	-	Common	WDS, SMK
97.	Black-winged Stilt *Himantopus himantopus*	M	LC	-	Common	WDS, DK, MHL, SMK
98.	Indian Stone-Curlew *Burhinus indicus*	R	LC	-	Rare	SGW, CNP, SMK
99.	Great Thick-knee *Esacus recurvirostris*	R	NT	-	Rare	DK
100.	Indian Courser *Cursorius coromandelicus*	R	LC	-	Common	SMK
101.	Brown-headed Gull *Larus brunnicephalus*	M	LC	-	Occasional	CNP
102.	Whiskered Tern *Chlidonias hybridus*	M	LC	-	Occasional	DK
103.	Gull-billed Tern *Gelochelidon nilotica*	M	LC	-	Occasional	CNP
104.	River Tern *Sterna aurantia*	R	NT	-	Common	DK, MHL
105.	Chestnut-bellied Sandgrouse *Pterocles exustus*	R	LC	-	Common	DK
106.	Grey-fronted Green-Pigeon *Treron affinis*	R	LC	Endemic	Rare	CNP
107.	Yellow-footed Green-Pigeon *Treron phoenicopterus*	R	LC	-	Common	CNP
108.	Green Imperial-Pigeon *Ducula aenea*	R	LC	-	Rare	CNP
109.	Rock Pigeon *Columba livia*	R	LC	-	Common	WDS, DK, CNP
110.	Nilgiri Wood-Pigeon *Columba elphinstonii*	R	VU	Endemic	Uncommon	CNP
111.	Oriental Turtle-Dove *Streptopelia orientalis*	R	LC	-	Common	CNP
112.	Eurasian Collared-Dove *Streptopelia decaocto*	R	LC	-	Common	SGW, DK
113.	Red Collared-Dove *Streptopelia tranquebarica*	R	LC	-	Common	DK, SGW, CNP
114.	Spotted Dove *Streptopelia chinensis*	R	LC	-	Common	DK, CNP, MHL
115.	Laughing Dove *Streptopelia senegalensis*	R	LC	-	Common	WDS, SGW, DK, CNP, MHL
116.	Emerald Dove *Chalcophaps indica*	R	LC	-	Common	CNP
117.	Alexandrine Parakeet *Psittacula eupatria*	R	NT	-	Rare	CNP
118.	Rose-ringed Parakeet *Psittacula krameri*	R	LC	-	Common	WDS, DK, CNP, MHL
119.	Plum-headed Parakeet *Psittacula cyanocephala*	R	LC	-	Common	SGW, CNP
120.	Malabar Parakeet *Psittacula columboides*	R	LC	Endemic	Uncommon	CNP
121.	Vernal Hanging-Parrot *Loriculus vernalis*	R	LC	-	Common	CNP
122.	Jacobin Cuckoo *Clamator jacobinus*	BR	LC	-	Common	SGW, DK, CNP
123.	Common Hawk-Cuckoo *Hierococcyx varius*	BR	LC	-	Common	SGW, DK, CNP, MHL, SMK

Table 1: Checklist of the birds of Sangli district (*contd.*)

Sr. No	Species	Status	Status IUCN	Endemic to India	Occurrence	Location
124.	Grey-bellied Cuckoo *Cacomantis passerinus*	BR	LC	-	Common	SGW, CNP
125.	Asian Koel *Eudynamys scolopaceus*	R	LC	-	Common	WDS, DK, CNP, MHL
126.	Sirkeer Malkoha *Taccocua leschenaultii*	R	LC	-	Uncommon	SGW
127.	Greater Coucal *Centropus sinensis*	R	LC	-	Common	WDS, SGW, DK, CNP, MHL
128.	Common Barn-Owl *Tyto alba*	R	LC	-	Occasional	SMK
129.	Oriental Scops-Owl *Otus sunia*	R	LC	-	Common	CNP, SMK
130.	Indian Scops-Owl *Otus bakkamoena*	R	LC	-	Common	CNP
131.	Indian Eagle-Owl *Bubo bengalensis*	R	LC	-	Occasional	SGW
132.	Dusky Eagle-Owl *Bubo coromandus*	R	LC	-	Rare	CNP
133.	Brown Fish-Owl *Ketupa zeylonensis*	R	LC	-	Common	CNP
134.	Jungle Owlet *Glaucidium radiatum*	R	LC	-	Common	CNP
135.	Spotted Owlet *Athene brama*	R	LC	-	Common	SMK
136.	Mottled Wood-Owl *Strix ocellata*	R	LC	Endemic	Rare	SMK, CNP
137.	Short-eared Owl *Asio flammeus*	M	LC	-	Occasional	SGW, CNP
138.	Ceylon Frogmouth *Batrachostomus moniliger*	R	LC	-	Rare	CNP
139.	Indian Jungle Nightjar *Caprimulgus indicus*	R	LC	-	Uncommon	SGW, CNP
140.	Indian Little Nightjar *Caprimulgus asiaticus*	R	LC	-	Common	SGW, DK, CNP
141.	Savanna Nightjar *Caprimulgus affinis*	LM	LC	-	Occasional	SGW, CNP
142.	Alpine Swift *Tachymarptis melba*	R	LC	-	Rare	CNP
143.	House Swift *Apus affinis*	R	LC	-	Common	SGW, DK, CNP
144.	Asian Palm-Swift *Cypsiurus balasiensis*	R	LC	-	Uncommon	CNP
145.	Crested Tree-Swift *Hemiprocne coronata*	R	LC	-	Common	CNP
146.	Malabar Trogon *Harpactes fasciatus*	R	LC	-	Uncommon	CNP
147.	Pied Kingfisher *Ceryle rudis*	R	LC	-	Common	WDS, DK, CNP, MHL, TR
148.	Common Kingfisher *Alcedo atthis*	R	LC	-	Common	WDS, SGW, DK, CNP, MHL, SMK
149.	Stork-billed Kingfisher *Pelargopsis capensis*	R	LC	-	Rare	CNP
150.	White-throated Kingfisher *Halcyon smyrnensis*	R	LC	-	Common	WDS, SGW, DK, CNP, MHL, SMK
151.	Blue-tailed Bee-eater *Merops philippinus*	PM	LC	-	Uncommon	CNP
152.	Small Green Bee-eater *Merops orientalis*	R	LC	-	Common	WDS, SGW, DK, CNP, MHL, SMK
153.	Indian Roller *Coracias benghalensis*	R	LC	-	Common	WDS, DK, CNP, SMK

Table 1: Checklist of the birds of Sangli district (*contd.*)

Sr. No	Species	Status	Status IUCN	Endemic to India	Occurrence	Location
154.	Common Hoopoe *Upupa epops*	R	LC	-	Common	WDS, SGW, DK, CNP, MHL
155.	Indian Grey Hornbill *Ocyceros birostris*	R	LC	-	Common	WDS, DK, MHL, SMK
156.	Malabar Grey Hornbill *Ocyceros griseus*	R	LC	Endemic	Uncommon	CNP
157.	Malabar Pied Hornbill *Anthracoceros coronatus*	R	NT	-	Common	CNP
158.	Great Pied Hornbill *Buceros bicornis*	R	NT	-	Rare	CNP
159.	Brown-headed Barbet *Megalaima zeylonica*	R	LC	-	Common	CNP
160.	White-cheeked Barbet *Megalaima viridis*	R	LC	Endemic	Common	CNP
161.	Coppersmith Barbet *Megalaima haemacephala*	R	LC	-	Common	DK, CNP, SMK
162.	Eurasian Wryneck *Jynx torquilla*	M	LC	-	Rare	SMK
163.	Rufous Woodpecker *Celeus brachyurus*	R	LC	-	Uncommon	CNP
164.	Black-rumped Flameback *Dinopium benghalense*	R	LC	-	Common	CNP
165.	Yellow-fronted Pied Woodpecker *Dendrocopos mahrattensis*	R	LC	-	Occasional	SGW, DK, CNP
166.	Indian Pygmy Woodpecker *Dendrocopos nanus*	R	LC	-	Occasional	CNP
167.	White-naped Flameback *Chrysocolaptes festivus*	R	LC	-	Rare	SMK
168.	Greater Flameback *Chrysocolaptes guttacristatus*	R	LC	-	Uncommon	CNP
169.	Indian Pitta *Pitta brachyura*	BR	LC	-	Common	CNP
170.	Singing Bushlark *Mirafra cantillans*	R	LC	-	Common	DK, SMK
171.	Indian Bushlark *Mirafra erythroptera*	R	LC	-	Common	DK, SMK
172.	Ashy-crowned Finch-Lark *Eremopterix griseus*	R	LC	-	Common	WDS, SMK, SGW, DK, CNP
173.	Rufous-tailed Lark *Ammomanes phoenicurus*	R	LC	-	Common	WDS, DK, SGW, SMK
174.	Malabar Lark *Galerida malabarica*	R	LC	Endemic	Common	CNP
175.	Syke's Lark *Galerida deva*	R	LC	Endemic	Common	DK, SMK
176.	Oriental Skylark *Alauda gulgula*	R	LC	-	Occasional	DK, SMK
177.	Grey-throated Sand Martin *Riparia chinensis*	M	LC	-	Rare	CNP
178.	Eurasian Crag-Martin *Ptyonoprogne rupestris*	M	LC	-	Rare	SGW
179.	Dusky Crag-Martin *Ptyonoprogne concolor*	R	LC	-	Common	SGW, DK, SMK, CNP
180.	Barn Swallow *Hirundo rustica*	M	LC	-	Common	WDS, DK, CNP, SMK
181.	Wire-tailed Swallow *Hirundo smithii*	R	LC	-	Common	WDS, SGW, DK, CNP, MHL, SMK
182.	Streak-throated Swallow *Hirundo fluvicola*	R	LC	-	Uncommon	CNP
183.	Red-rumped Swallow *Hirundo daurica*	R/M	LC	-	Common	WDS, SGW, DK, CNP, SMK

Table 1: Checklist of the birds of Sangli district (*contd.*)

Sr. No	Species	Status	Status IUCN	Endemic to India	Occurrence	Location
184.	Olive-backed Pipit *Anthus hodgsoni*	M	LC	-	Common	CNP
185.	Tree Pipit *Anthus trivialis*	M	LC	-	Common	SGW, DK, CNP, SMK
186.	Paddyfield Pipit *Anthus rufulus*	R	LC	-	Common	WDS, DK, SMK
187.	Tawny Pipit *Anthus campestris*	M	LC	-	Occasional	SGW, DK, SMK
188.	Forest Wagtail *Dendronanthus indicus*	M	LC	-	Rare	CNP
189.	Western Yellow Wagtail *Motacilla flava*	M	LC	-	Common	WDS, SGW, DK, CNP, MHL
190.	Black-headed Yellow Wagtail *Motacilla flava melanogrisea*	M	LC	-	Occasional	WDS, CNP, SMK
191.	Citrine Wagtail *Motacilla citreola*	M	LC	-	Common	SMK, MHL
192.	Grey Wagtail *Motacilla cinerea*	M	LC	-	Common	DK, SMK, CNP
193.	White Wagtail *Motacilla alba*	M	LC	-	Common	WDS, DK, SMK, MHL
194.	White-browed Wagtail *Motacilla maderaspatensis*	R	LC	-	Common	WDS, DK,CNP, SMK
195.	Pied Flycatcher-Shrike *Hemipus picatus*	NK	LC	-	Rare	CNP
196.	Common Woodshrike *Tephrodornis pondicerianus*	R	LC	-	Common	SGW, DK, CNP
197.	Large Cuckooshrike *Coracina macei*	NK	LC	-	Uncommon	CNP
198.	Black-headed Cuckooshrike *Coracina melanoptera*	R	LC	-	Occasional	SMK, CNP
199.	Scarlet Minivet *Pericrocotus flammeus*	R	LC	-	Common	CNP
200.	Small Minivet *Pericrocotus cinnamomeus*	R	LC	-	Common	SGW, DK, SMK
201.	Red-whiskered Bulbul *Pycnonotus jocosus*	R	LC	-	Common	CNP
202.	Red-vented Bulbul *Pycnonotus cafer*	R	LC	-	Common	WDS, SGW, DK, CNP, MHL, SMK
203.	White-browed Bulbul *Pycnonotus luteolus*	R	LC	-	Occasional	SMK, CNP
204.	Yellow-browed Bulbul *Iole indica*	R	LC	-	Common	CNP
205.	Square-tailed Black Bulbul *Hypsipetes ganeesa*	R	LC	-	Common	CNP
206.	Common Iora *Aegithina tiphia*	R	LC	-	Common	SGW, DK, CNP
207.	Golden-fronted Leafbird *Chloropsis aurifrons*	R	LC	-	Common	CNP
208.	Asian Fairy Bluebird *Irena puella*	R	LC	-	Rare	CNP
209.	Southern Grey Shrike *Lanius meridionalis*	R	LC	-	Common	SMK
210.	Bay-backed Shrike *Lanius vittatus*	R	LC	-	Common	WDS, SGW, DK, CNP, SMK
211.	Isabelline Shrike *Lanius isabellinus*	M	LC	-	Rare	SGW
212.	Long-tailed Shrike *Lanius schach*	R/M	LC	-	Common	WDS, SGW, DK, CNP, MHL, SMK
213.	Brown Shrike *Lanius cristatus*	M	LC	-	Common	CNP

Table 1: Checklist of the birds of Sangli district (*contd.*)

Sr. No	Species	Status	Status IUCN	Endemic to India	Occurrence	Location
214.	Bluethroat *Luscinia svecica*	M	LC	-	Occasional	SMK, WDS, CNP
215.	Indian Blue Robin *Luscinia brunnea*	M	LC	-	Uncommon	CNP
216.	Oriental Magpie-Robin *Copsychus saularis*	R	LC	-	Common	WDS, DK, SGW, CNP, SMK
217.	White-rumped Shama *Copsychus malabaricus*	R	LC	-	Rare	CNP
218.	Black Redstart *Phoenicurus ochruros*	M	LC	-	Common	SGW, CNP
219.	Common Stonechat *Saxicola torquata*	M	LC	-	Common	WDS, DK, CNP, SMK
220.	Pied Bushchat *Saxicola caprata*	R	LC	-	Common	WDS, DK, CNP, SMK
221.	Indian Black Robin *Saxicola fulicata*	R	LC	-	Common	WDS, SGW, DK, CNP, MHL
222.	Blue-headed Rock-Thrush *Monticola cinclorhynchus*	M	LC	-	Uncommon	CNP
223.	Blue Rock-Thrush *Monticola solitarius*	M	LC	-	Occasional	SGW, CNP
224.	Malabar Whistling-Thrush *Myophonus horsfieldii*	R	LC	Endemic	Common	CNP
225.	Orange-headed Thrush *Zoothera citrina*	R	LC	-	Common	CNP
226.	Indian Blackbird *Turdus simillimus*	R	LC	-	Common	SGW, CNP
227.	Puff-throated Babbler *Pellorneum ruficeps*	R	LC	-	Common	CNP
228.	Indian Scimitar Babbler *Pomatorhinus horsfieldii*	R	LC	Endemic	Uncommon	CNP
229.	Tawny-bellied Babbler *Dumetia hyperythra*	R	LC	-	Common	DK, CNP
230.	Yellow-eyed Babbler *Chrysomma sinense*	R	LC	-	Common	WDS, SMK, SGW, DK, CNP
231.	Common Babbler *Turdoides caudata*	R	LC	-	Common	WDS, SGW, DK
232.	Large Grey Babbler *Turdoides malcolmi*	R	LC	-	Uncommon	SGW, DK, CNP
233.	Indian Rufous Babbler *Turdoides subrufa*	R	LC	Endemic	Rare	CNP
234.	Jungle Babbler *Turdoides striata*	R	LC	-	Common	SGW, CNP
235.	Brown-cheeked Fulvetta *Alcippe poioicephala*	R	LC	-	Uncommon	CNP
236.	Asian Brown Flycatcher *Muscicapa daurica*	M	LC	-	Occasional	WDS, SMK
237.	Rusty-tailed Flycatcher *Muscicapa ruficauda*	M	LC	-	Occasional	WDS
238.	Red-throated Flycatcher *Ficedula parva*	M	LC	-	Common	SGW, DK, CNP
239.	White-bellied Blue Flycatcher *Cyornis pallipes*	R	LC	-	Rare	CNP
240.	Tickell's Blue Flycatcher *Cyornis tickelliae*	R	LC	-	Occasional	SGW, CNP
241.	Verditer Flycatcher *Eumyias thalassina*	R	LC	-	Occasional	CNP
242.	White-browed Fantail *Rhipidura aureola*	R	LC	-	Uncommon	CNP
243.	White-throated Fantail *Rhipidura albicollis*	R	LC	Endemic	Common	WDS, SGW, DK, CNP, SMK

Table 1: Checklist of the birds of Sangli district (*contd.*)

Sr. No	Species	Status	Status IUCN	Endemic to India	Occurrence	Location
244.	Asian Paradise-Flycatcher *Terpsiphone paradisi*	R	LC	-	Common	CNP
245.	Black-naped Monarch *Hypothymis azurea*	R	LC	-	Uncommon	CNP
246.	Zitting Cisticola *Cisticola juncidis*	R	LC	-	Common	SGW, DK, CNP
247.	Grey-breasted Prinia *Prinia hodgsonii*	R	LC	-	Common	SGW, CNP
248.	Plain Prinia *Prinia inornata*	R	LC	-	Common	SGW, DK, SMK, CNP
249.	Ashy Prinia *Prinia socialis*	R	LC	-	Common	WDS, DK, SMK, CNP
250.	Jungle Prinia *Prinia sylvatica*	R	LC	-	Common	SGW, DK, CNP
251.	Common Tailorbird *Orthotomus sutorius*	R	LC	-	Common	SGW, DK, SMK, CNP
252.	Indian Reed-Warbler *Acrocephalus stentoreus*	R/M	LC	-	Common	SGW, DK
253.	Blyth's Reed-Warbler *Acrocephalus dumetorum*	M	LC	-	Common	CNP
254.	Booted Warbler *Hippolais caligata*	M	LC	-	Occasional	CNP
255.	Eastern Orphean Warbler *Sylvia hortensis*	M	LC	-	Occasional	WDS, DK
256.	Lesser Whitethroat *Sylvia curruca halimodendri*	M	LC	-	Occasional	WDS, SGW, DK
257.	Siberian Chiffchaff *Phylloscopus* (*collybita*) *tristis*	M	LC	-	Common	WDS, SGW, CNP
258.	Greenish Warbler *Phylloscopus trochiloides*	M	LC	-	Occasional	CNP, SGW
259.	Great Tit *Parus major*	R	LC	-	Common	SMK, SGW, CNP
260.	Indian Yellow Tit *Parus aplonotus*	R	LC	Endemic	Common	CNP
261.	Indian Nuthatch *Sitta castanea*	R	LC	-	Occasional	CNP
262.	Velvet-fronted Nuthatch *Sitta frontalis*	R	LC	-	Occasional	CNP
263.	Thick-billed Flowerpecker *Dicaeum agile*	R	LC	-	Common	CNP
264.	Pale-billed Flowerpecker *Dicaeum erythrorhynchos*	R	LC	-	Common	CNP
265.	Nilgiri Flowerpecker *Dicaeum concolor*	R	LC	Endemic	Common	CNP
266.	Purple-rumped Sunbird *Leptocoma zeylonica*	R	LC	-	Common	SMK, MHL, SGW
267.	Small Sunbird *Leptocoma minima*	R	LC	-	Common	CNP
268.	Loten's Sunbird *Cinnyris lotensis*	R	LC	-	Rare	CNP
269.	Purple Sunbird *Cinnyris asiatica*	R	LC	-	Common	CNP, SMK, WDS
270.	Vigors's Sunbird *Aethopyga vigorsii*	R	LC	Endemic	Rare	CNP
271.	Oriental White-eye *Zosterops palpebrosa*	R	LC	-	Common	CNP, WDS, SMK
272.	Black-headed Bunting *Emberiza melanocephala*	M	LC	-	Common	SMK, SGW DK
273.	Grey-necked Bunting *Emberiza buchanani*	M	LC	-	Uncommon	SGW, CNP

Table 1: Checklist of the birds of Sangli district (*contd.*)

Sr. No	Species	Status	Status IUCN	Endemic to India	Occurrence	Location
274.	Crested Bunting *Melophus lathami*	R	LC	-	Common	CNP
275.	Common Rosefinch *Carpodacus erythrinus*	M	LC	-	Common	SMK, MHL, CNP
276.	Red Avadavat *Amandava amandava*	R	LC	-	Uncommon	WDS, CNP, MHL
277.	Indian Silverbill *Lonchura malabarica*	R	LC	-	Common	DK, SMK, MHL
278.	Scaly-breasted Munia *Lonchura punctulata*	R	LC	-	Common	SMK, SGW, DK, MHL
279.	Tricoloured Munia *Lonchura malacca*	R	LC	-	Rare	SMK, WDS, CNP
280.	House Sparrow *Passer domesticus*	R	LC	-	Common	SMK, SGW, WDS, MHL
281.	Yellow-throated Sparrow *Petronia xanthocollis*	R	LC	-	Common	CNP, SGW
282.	Baya Weaver *Ploceus philippinus*	R	LC	-	Common	SMK, DK, MHL, SGW
283.	Grey-headed Starling *Sturnus malabaricus*	LM	LC	-	Rare	CNP
284.	Brahminy Starling *Sturnia pagodarum*	R	LC	-	Common	SMK, SGW, WDS
285.	Rosy Starling *Sturnus roseus*	M	LC	-	Common	SMK, SGW
286.	Common Myna *Acridotheres tristis*	R	LC	-	Common	WDS, SMK, SGW
287.	Jungle Myna *Acridotheres fuscus*	R	LC	-	Common	CNP, SGW, SMK
288.	Indian Golden Oriole *Oriolus kundoo*	R	LC	-	Common	CNP, SGW
289.	Black-hooded Oriole *Oriolus xanthornus*	R	LC	-	Common	CNP
290.	Black Drongo *Dicrurus macrocercus*	R	LC	-	Common	WDS, SMK, SGW
291.	Ashy Drongo *Dicrurus leucophaeus*	R	LC	-	Common	CNP
292.	Bronzed Drongo *Dicrurus aeneus*	NK	LC	-	Rare	CNP
293.	Greater Racket-tailed Drongo *Dicrurus paradiseus*	R	LC	-	Rare	CNP
294.	White-bellied Drongo *Dicrurus caerulescens*	R	LC	-	Common	CNP
295.	House Crow *Corvus splendens*	R	LC	-	Common	WDS, SMK, SGW
296.	Jungle Crow *Corvus macrorhynchos*	R	LC	-	Common	CNP, WDS, SMK, SGW
297.	Rufous Treepie *Dendrocitta vagabunda*	R	LC	-	Common	CNP

LC – Least Concern, **NT** – Near Threatened, **VU** – Vulnerable, **EN** – Endangered, **CR** – Critically Endangered
R: Resident, **M**: Migrant, **BR:** Breeding Migrant, **LM**: Local Migrant, **NK**: Status Unknown, **PM**: Passage Migrant, **V:** Vagrant, **R/M**: Resident as well as migrant
Common: Species observed repeatedly in suitable habitat, **Uncommon:** Species occurs on a regular basis, but not frequently in suitable habitat, **Occasional:** Species that were recorded occasionally in suitable habitat, **Rare:** Species was sporadically/rarely sighted in suitable habitat
WDS – Waste Disposal Site, **SGW** – Sagareshwar Sanctuary, **DK**–Dabhai Kuran, **CNP** – Chandoli National Park, **SMK** – Sangli, Miraj, Kupwad city and nearby areas, **MHL** – Mhaisal, **TR** – Tanks and Reservoirs.
Note: The Municipal Corporation of Sangli includes three towns, namely **S**angli, **M**iraj, and **K**upwad which were separate municipalities earlier. Observations recorded under the abbreviation SMK indicate the sightings of birds within the corporation limits, and in the villages and the hills within a radius of approximately 20 km around Miraj.

Kumbhari village (13 km from Jath) until 1960, which was corroborated by two of his colleagues.

Endemic Species[5]

Nineteen of the species that occur in the district are endemic to India (Table 1), and the status and distribution of some of these species are discussed below:

Nilgiri Wood-Pigeon *Columba elphinstonii*: The Nilgiri Wood-Pigeon, endemic to the Western Ghats, was reported from Chandoli National Park by Green Guards (Gole 1998). Being nomadic, this species is irregularly seen in the Park.

Malabar Parakeet *Psittacula columboides*: The Malabar Parakeet, endemic to the Western Ghats, was recorded from Chandoli National Park by Green Guards (Jathar and Kulkarni 2005; Kulkarni 2012). The species was seen in flocks of 10–15 birds in March on trees such as *Bombax ceiba*, *Butea monosperma* and *Erythrina* sp., feeding on nectar and flowers (Jathar and Kulkarni 2005)

Malabar Trogon *Harpactes fasciatus*: The Malabar Trogon was occasionally recorded in well-wooded areas along the Sahyadri range by Butler (1881). It has been sighted in Chandoli National Park by Green Guards.

Nilgiri Flowerpecker *Dicaeum concolor*: The Nilgiri Flowerpecker is a common resident in Chandoli National Park (Gole 1998), and was also reported by Green Guards. This bird was often seen feeding on *Loranthus* when the plants bloom (Jathar *pers. comm.*). The Nilgiri Flowerpecker is not recognised as a separate species by BirdLife International, but is lumped under Plain Flowerpecker *D. concolor*, which also has populations in the Himalaya, northeastern India, Northeastern Hill states, Bangladesh, and the Nicobars.

Vigors's Sunbird *Aethopyga vigorsii*: Vigors's Sunbird is endemic to the northern parts of Western Ghats from Mumbai to Goa. This bird has been reported from the western seaward slopes of Chandoli National Park by Green Guards. Vigor's Sunbird is not recognised as a separate species by BirdLife International, but is lumped under Crimson Sunbird *A. siparaja*, which also has populations in the north-east India, Bangladesh, and Myanmar.

Heronries and Roosts

Black-crowned Night-Heron *Nycticorax nycticorax*: Butler (1881) stated that the Black-crowned Night-Heron was not uncommon throughout the region. We found the species to be a common resident species in the district. Apte (1995) reported it at Dabhai, where it is a resident and seen occasionally. Green Guards reported it from Chandoli National Park (Green Guards, unpublished data). Apte reports a breeding colony in L.B. Shastri Udyan in Sangli city. The birds have been nesting at this site since 2007. The breeding season is from April to September, and around 60 nests and 120–150 birds were recorded. After September, the birds use the same trees for roosting (Sharad Apte *pers. comm.*).

Eastern Cattle-Egret *Bubulcus coromandus*: A small roosting colony of the Eastern Cattle-Egret was reported from Miraj by Bhagwat and Ramteerthkar (1991). The roosting is heterospecific, with Little Egret *Egretta garzetta*, House Crow *Corvus splendens*, and Common Myna *Acridotheres tristis*. Cattle egrets dominate the roost and prefer the central *Ficus benghalensis* tree, while the others use the surrounding trees such as Cassia and Rain tree. An average count of 540 roosting birds was reported (Bhagwat 1991). Several attempts by locals to drive away the birds proved to be unsuccessful and the site has been the roosting colony in the campus of Government Medical College, Miraj for several years.

Rose-ringed Parakeet *Psittacula krameri*: The Rose-ringed Parakeet has a wide distribution in Sangli. It is a common resident at the WDS area (Tuljapurkar and Bhagwat 2007). At Sagareshwar, it is a local migrant and not sighted much (Apte, unpublished). It is a common, breeding resident in the Dabhai area (Apte 1995; V.R. Bhagwat unpublished data). It is also seen in Chandoli National Park (Green Guards) and Mhaisal (Deepak Shinde *pers. comm.*). Another major site where thousands of birds congregate in peepul trees *Ficus religiosa* is at Haripur, a small village near Sangli situated at the confluence of Krishna and Warana rivers.

Rosy Starling *Sturnus roseus*: It is a common winter migrant seen near cultivation through out Sangli district. The earliest date of arrival recorded was December 22, and last date of departure was March 27 (Bhagwat 2002). In the peak season, more than 5000 birds were recorded (Bhagwat, unpublished). It is often sighted at WDS (Tuljapurkar and Bhagwat 2007) and Dabhai (Apte 1995). In early March, Rosy Starlings are seen in Sangli city. There are two huge trees in the heart of the town near the Municipal Corporation building. Hundreds of birds congregate on these trees in the evening and fly in large circles with loud calls before they settle down to roost. Somewhere in the third week of March, they take off *en masse* on their northward journey, after which the trees are a roost site for crows and mynas till the starlings return the following year.

CONSERVATION ISSUES

Based on our 20 odd years of birding in the district and from other accounts, there appears to be an overall decline in the birdlife of the area especially in the last decade. Species such as Indian Courser *Cursorius coromandelicus* and Yellow-wattled Lapwing *Vanellus malabaricus*, which were common earlier, are disappearing. The White-eyed Buzzard *Butastur teesa* was a common species according to Butler (1881), but now its sightings are rare. The House Sparrow *Passer domesticus* also appears to have undergone a decline since the past ten years. There are many factors responsible for the decline of these and other bird species, the major cause being changes in land use. However, a few species appear to have increased in numbers. Butler (1881) reported that the Indian Peafowl *Pavo cristatus* is essentially a jungle bird and people killed it in large numbers, but it is now widely distributed in Sangli district. Bhagwat (2002) reported an increased number of Indian Cattle-Egret *Bubulcus coromandus* at WDS and at the roosting site in Miraj, compared to his observations in 1991 (Bhagwat and Ramteerthkar 1991).

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[5] Endemic bird species of the district defined by following Jathar and Rahmani (2006)

The western part of the district, which is dominated by the hills of Western Ghats, faces different challenges, the major challenge being clearance of forests for agricultural expansion. Major chunks of forest belonging to private land owners have been converted into sugar cane fields. Another major threat is bauxite mining, which is taking place in all the laterite plateaux that are the breeding ground for the endemic Malabar Lark *Galerida malabarica*. Commercial extraction of firewood from private forests, forest fires, rampant cattle grazing, and collection of medical plants are other threats. The industries that have come up on the banks of River Krishna are causing pollution, impacting waterbirds.

To save the forests and other habitats, a network of protected and intact habitats of the region needs to be created. Places such as Dabhai Kuran, Jath, Kavathe Mahankal (grasslands), Banpuri and other tanks in Atpadi (wetlands), and Dandoba hill (forests) needs special protection. These are important sites for the biodiversity of the region, and can play a significant role in conservation of the avifauna and other wildlife.

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NOTES ON THE NEWLY DISCOVERED POPULATION OF SIND JERDON'S BABBLER *CHRYSOMMA ALTIROSTRE SCINDICUM* IN HARIKE WILDLIFE SANCTUARY, PUNJAB, INDIA

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Jerdon's Babbler *Chrysomma altirostre* is native to India, Pakistan, and Myanmar, and is classified as Vulnerable by IUCN. The western race of the species, namely *scindicum*, was known only from a few localities in the floodplains of the Indus river and its tributaries in Pakistan, till it was recorded in Harike Wildlife Sanctuary, Punjab, India, in October 2012. During a follow-up study in Harike in December 2012, 33 individuals were recorded, which suggested that Harike wetland could have a significant population of this species and the subspecies *scindicum* in India. The assemblage of tall, dense, long, and unbroken grass stands of *Phragmites-Saccharum-Imperata* were found to be important for the species. This paper discusses the observations and localities where the birds were recorded, and the sonograms of their calls and songs.

Key words: Jerdon's Babbler, *Chrysomma altirostre*, Timaliidae, babblers, Harike

INTRODUCTION

Jerdon's Babbler *Chrysomma altirostre* (Jerdon 1862) is native to India, Pakistan, and Myanmar, inhabiting tall grasslands and reed beds of river floodplains and marshes (Ali and Ripley 1987). It has three subspecies, *altirostre*, *griseigularis*, and *scindicum*, which show plumage differences. *C. a. griseigularis* is reported from India in the Brahmaputra and Gangetic floodplains (Terai). *C. a. altirostre* is known from the Irrawaddy-Sittang plains of Myanmar. *C. a. scindicum* was known only from its small populations spread in a few localities across the Indus river and its tributaries in Pakistan (Ali and Ripley 1987; Harington 1915; Roberts 1992).

The known sites of *scindicum* in Pakistan are Dadu, Khairpur, Larkana, and Shaheed Benazeerabad districts in Sind; Dera Ghazi Khan, Dera Ismail Khan, Mianwali, and Muzaffargarh districts between the southern part of the NW Frontier and SW Punjab provinces. The type specimen is from Mangrani, between Sukkur and Shikarpur in Sind province. Old records are from near Bhamb (Mianwali district), Jampur (Dera Ghazi Khan district) and Khanwah (Muzaffargarh district). Recent records (more than a decade old) are from the Dera Ismail Khan district, Dhap Shumali, Taunsa Barrage, and Chashma Barrage, which is the northernmost known site for this subspecies (Showler and Davidson 1999). Even in its strongholds, the species is very rare and the overall population trend is stated to be rapidly declining, primarily due to habitat loss, and is therefore classified as Vulnerable (Vulnerable A2c+3c+4c) by IUCN (BirdLife International 2012).

In October 2012, while birdwatching in Harike Wildlife Sanctuary, Punjab, which is about 350 km from the nearest known locality (Bhamb, Mianwali district, Pakistan), we (Saurabh Sawant, Shashank Dalvi, and Gunjan Arora) obtained sightings of *C. a. scindicum*. Our sighting is the first record of this subspecies from India. Based on its earlier known distribution and global status (Vulnerable), the sighting is significant, and thus a study of this population was undertaken in Harike from December 18–26, 2012. The status and other aspects of the Sind Jerdon's Babbler in this newly discovered locality are discussed in this paper.

STUDY AREA

Harike Wildlife Sanctuary is situated in Kapurthala, Ferozepur, and Amritsar districts of Punjab. It is a Ramsar site and a very important habitat for a large number of migratory waterfowl and many resident birds, and is recognised as an Important Bird Area of India (Islam and Rahmani 2004). Rich in aquatic flora and fauna, the wetland used to have a spread of over 86 sq. km, with about 50% of the area under submergence. However, over the years, the waterspread has declined to about 8–10 sq. km due to siltation and encroachment. The wetland is formed by the coalescence of the rivers Satluj and Beas that originate from the Himalaya before flowing towards the barrage.

Extensive growth of *Typha elephantina* and *Phragmites karka* occurs along the margins of Harike lake, in surrounding low-lying areas, and in the upstream area of Mand. Free floating *Azolla* occurs in patches on the open water. The tall grasses *Saccharum spontaneum* and *S. bengalense* are common along the higher ground of the wetlands and on the slopes and margins of the surrounding bunds and dykes. *Tamarix dicola* is the only woody plant seen in the aquatic

Table 1: Sites where Jerdon's Babbler was recorded during the survey

Site	No. of points	Seen	Heard	Total birds
Kiriyan-I	6	-	3	3
Kiriyan-II	13	5	8	13
Riyasat	16	6	4	10
LMB	3	-	2	2
Bhootiwala	10	2	3	5
Total	48	13	20	33

zone, the rest of the tree species occur at the borders of the wetland (Chandigarh Bird Club (2010): Harike Wetland Survey Report)

The climate is influenced by the Himalaya and has a direct bearing on the ecosystem. The temperature varies from 43°C in June to 0.6°C in January. The annual rainfall is about 670 mm, 70% received from the Southwest Monsoon (Chopra *et al.* 2001). Harike supports 7 species of turtle and 26 species of fish, and the larger mammals include Smooth-coated Otter *Lutrogale perspicillata*, Jungle Cat *Felis chaus*, Golden Jackal *Canis aureus*, Wild Pig *Sus scrofa*, and Common Mongoose *Herpestes edwardsii*. Harike attracts a large number of migratory birds in winter (Chandigarh Bird Club (2010): Harike Wetland Survey Report)

METHODS

The Sanctuary was surveyed prior to data collection for potential habitat of the species. Google Earth map and a boat map of Harike Wetland, obtained from WWF-India and Punjab Forest Department, were used to select and visit different locations in the Sanctuary. Through these, suitable habitats were identified, namely Kiriyan-I, Riyasat, Bhootiwala, LMB (Lower Marginal Bund), and Kiriyan-II, and these sites were visited by rowboat or motorboat.

As Jerdon's Babbler inhabits dense and marshy grasslands, it is difficult to sight them, and hence, only point counts were carried out at identified sites. The distances between points were kept at a minimum of 100–150 m, taking into account the farthest distance of response detection to playback calls, which was from our earlier observations. Though a great skulker, this species is very responsive to playback calls, and detection was determined based on its response to playback calls. A 26 sec. recording of *C. a. griseigularis*, converted at 128 kbps was used for the playbacks. It consisted of single bird singing at four intervals spread over 26 seconds of the typical *chi-chi-chi-chew-chew-chew* song. Complete recording was played for 26 sec., stopped for the next two minutes, and then played back again for the same length of time if no response was obtained. This procedure was not repeated more than twice for a site. On response, the number of individuals heard or sighted was counted and the GPS readings recorded. The birds were observed with binoculars and observations of habits, activity, and habitat were noted down. Photographs were taken and calls were also recorded whenever possible.

RESULTS AND DISCUSSION

Population and Distribution

Jerdon's Babbler was detected at 20 of the 48 points sampled, with 33 birds detected (Table 1). The majority of the birds (23) were detected at the Kiriyan-II and Riyasat areas, both located in the Sanctuary with large islets having extensive stands of tall and dense grasslands at the core. The rest of the birds were detected in the Kiriyan-I, Lower Marginal Bund and Bhootiwala areas. Bhootiwala has a good expanse of suitable habitat, but is surrounded by fields on the bank of Satluj. The other areas/regions of the Sanctuary, namely Harike Marar, Churian, Makhu, and Kot Khaim Khan appear to have unsuitable habitat for the species.

Habitat

Jerdon's Babbler was observed to frequent tall and dense grass stands of mainly *Phragmites*, *Saccharum*, and *Imperata* on islets in the wetland. The species recorded were *Phragmites karka*, *Saccharum bengalense*, *Saccharum spontaneum,* and *Imperata cylindrica.* The bird was never seen if these grasses occurred as small patches. Another species of tall grass *Arundo donax* grows mostly on the margins of the islands, but the bird was not recorded there. It also appears to prefer marshier and wetter areas than relatively dry, hard ground, perhaps due to the denser and extensive reed beds occurring in the former (Fig. 1).

Habits

The babblers were mostly seen singly or in pairs, and in small flocks, on a few occasions, consisting of 5–10 birds. At one location, a flock of five was observed moving on one side of a water channel and two birds were calling from the other side of the channel, not wider than 90–120 cm. Birds in the flocks are sparsely spread out. The babblers always remained in the grass. As detection was based on playback response, feeding habits could not be observed.

Plumage

The observed birds were paler on the upperparts including crown and upper tail, matching the descriptions of *C. a. scindicum* rather than *C. a. griseigularis*, which sports much warmer, darker ferruginous tones on the upperparts.

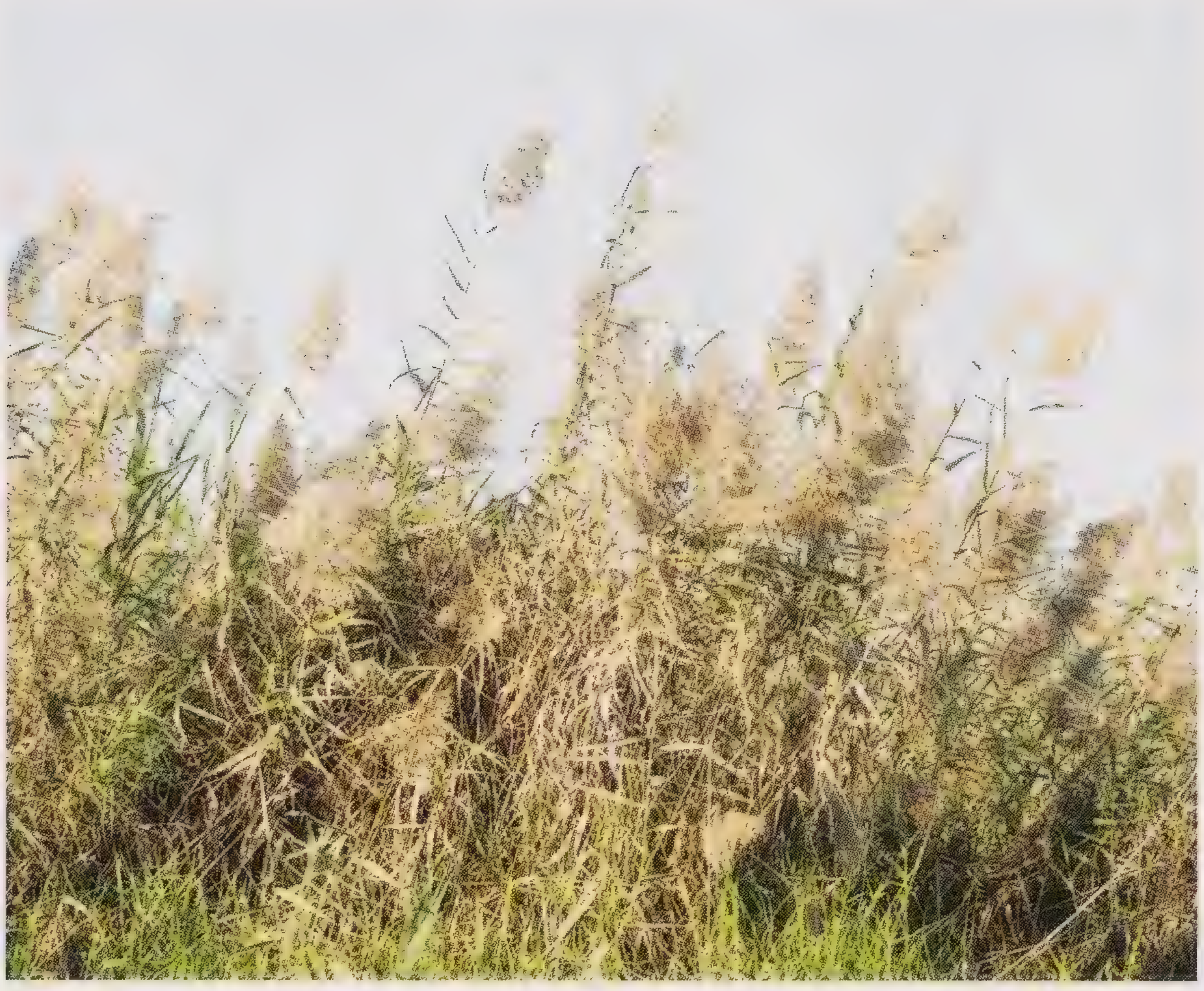


Fig. 1: Habitat of *Chrysomma altirostre scindicum*

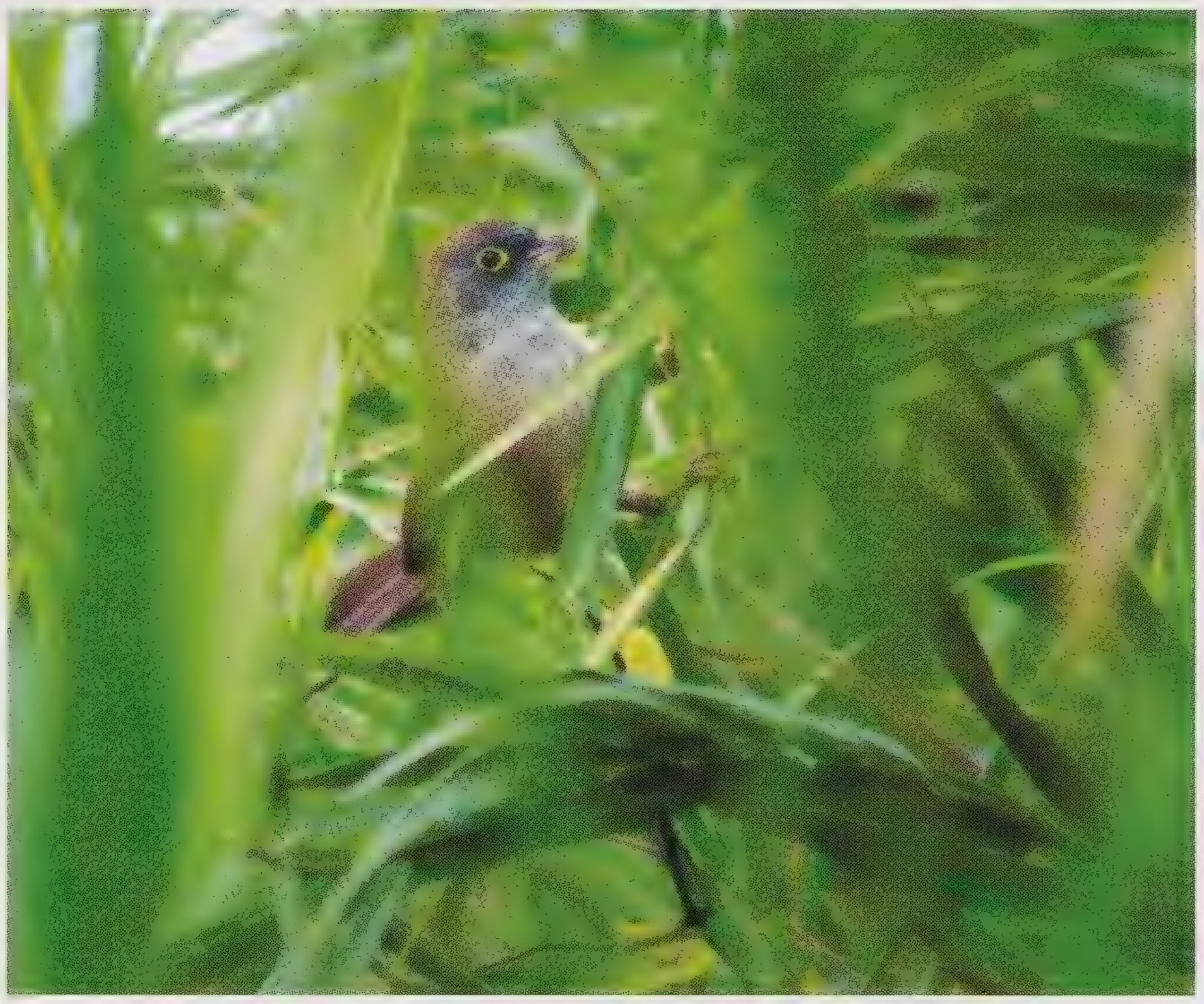


Fig. 2: *Chrysomma altirostre griseigularis* from Dibru Saikhowa, Assam

On the underparts, most birds were observed to be a little paler than *C. a. griseigularis*. The chin and throat were paler (whiter). The sides of the throat, which have a grey wash in adult *griseigularis*, were also observed to be considerably paler. Though the young birds of both species (identified by their fleshy pink lower mandibles) have a whitish throat, it is overall paler in *scindicum* than in *griseigularis* (Sawant 2012, *pers. obs.* in Harike and Dibru Saikhowa, Assam) (Figs 2, 3)

Vocalization

Jerdon's Babbler was found to be very responsive to playback, but became uninterested and stopped responding if the playback was repeated a number of times. Therefore, one must be careful while using playback for detailed observations, and a strict protocol must be followed. *C. a. scindicum* responded without any hesitation to the recordings of *C. a. griseigularis* (see Sonogram s3). *C. a. scindicum* was observed to sing in the early mornings and evenings. The call was delivered while perching around 30 cm below the tip of 3–4 m tall reeds. Two types of calls were heard and recorded.

The first appears to be a contact or alarm call, consisting of short notes of *tsik-tsik-tsik-tsik* and *ts-tsik ts-tsik ts-tsik* continuously repeated. These notes are produced continuously as the bird moves through the dense reeds, around a height of 1.5–2.5 m above the ground. It moves among the closely placed strands by hopping and perching in a slanting or almost

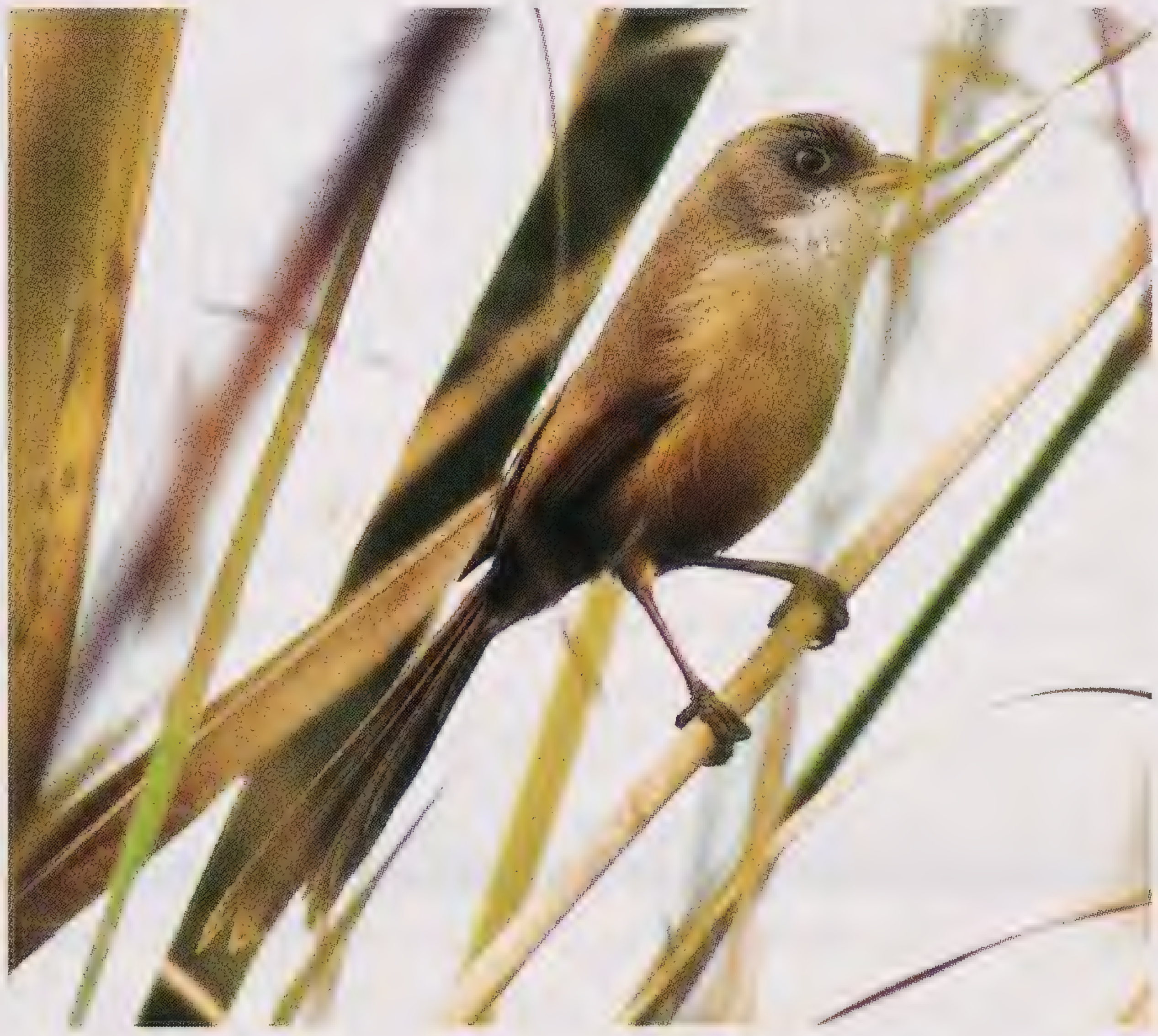


Fig. 3: *Chrysomma altirostre scindicum*, Harike, Punjab, India (2012)

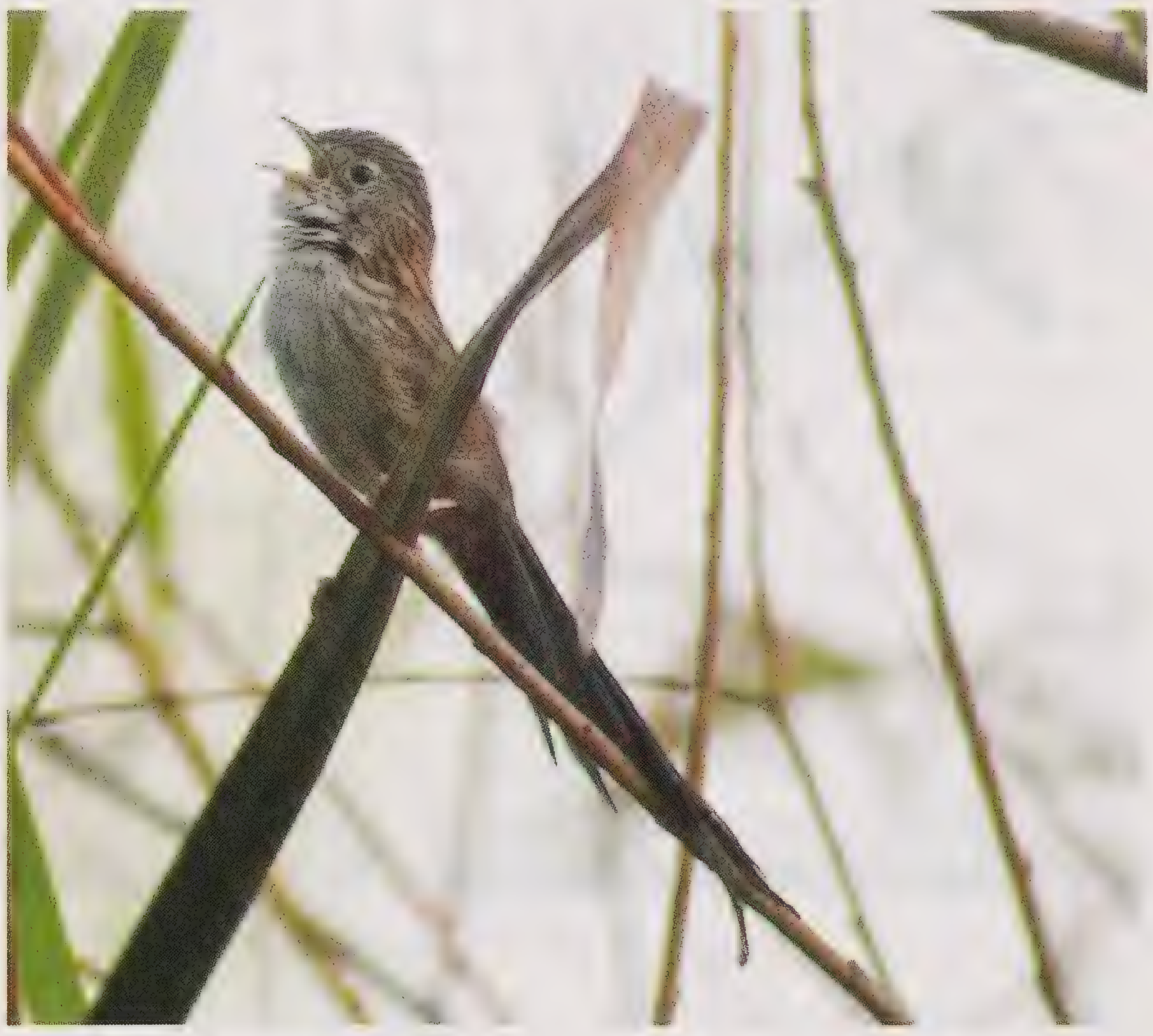
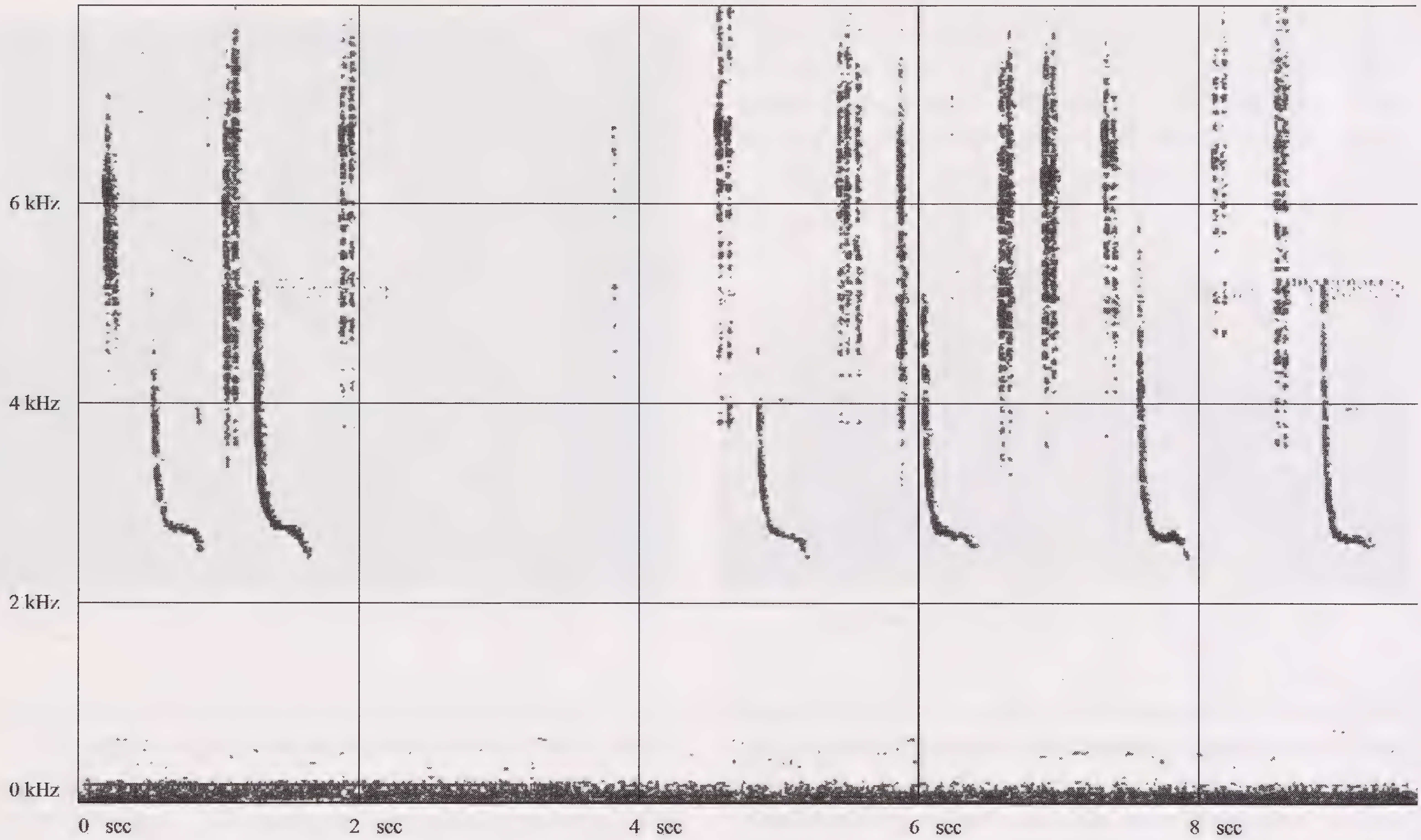
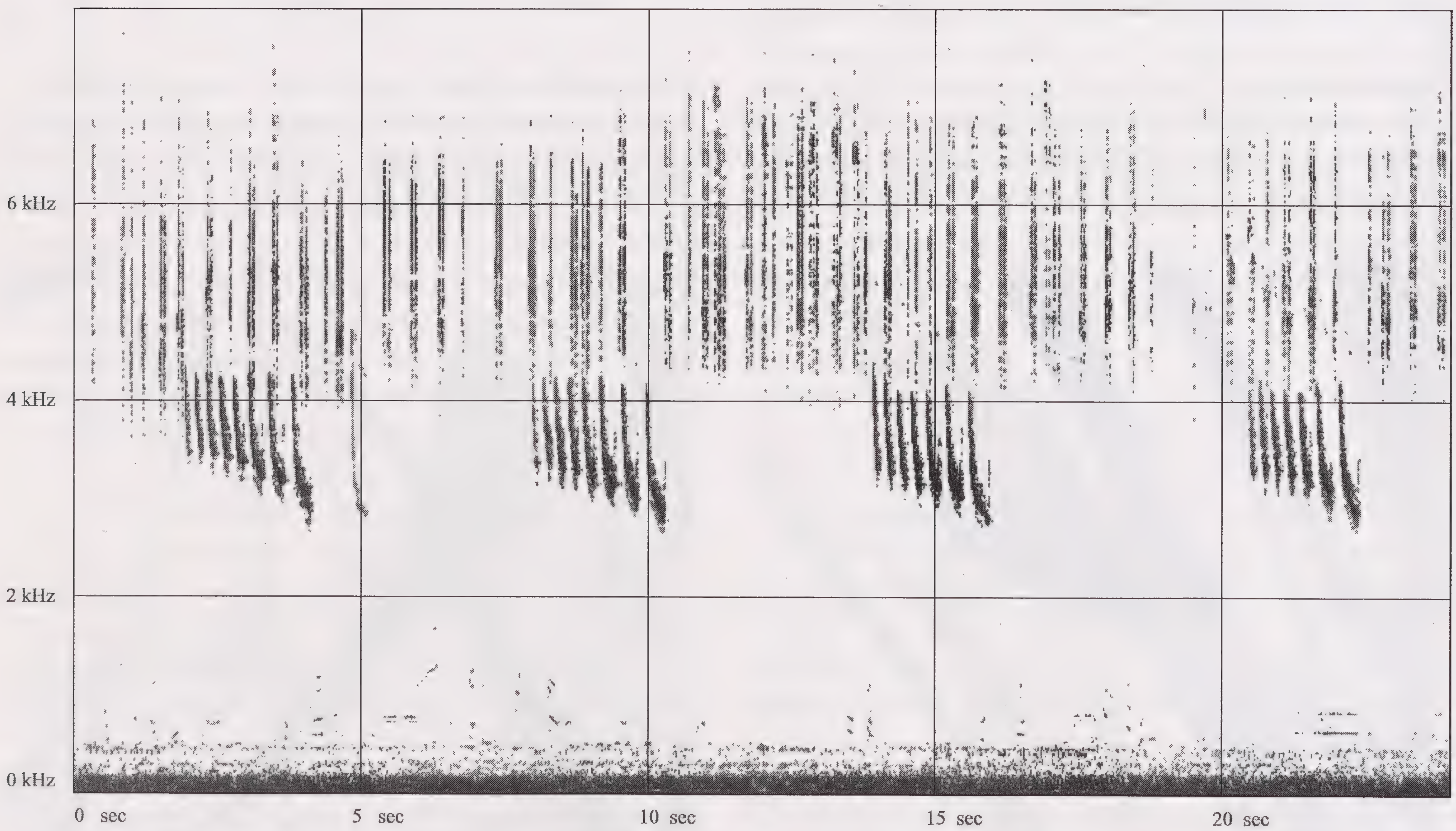


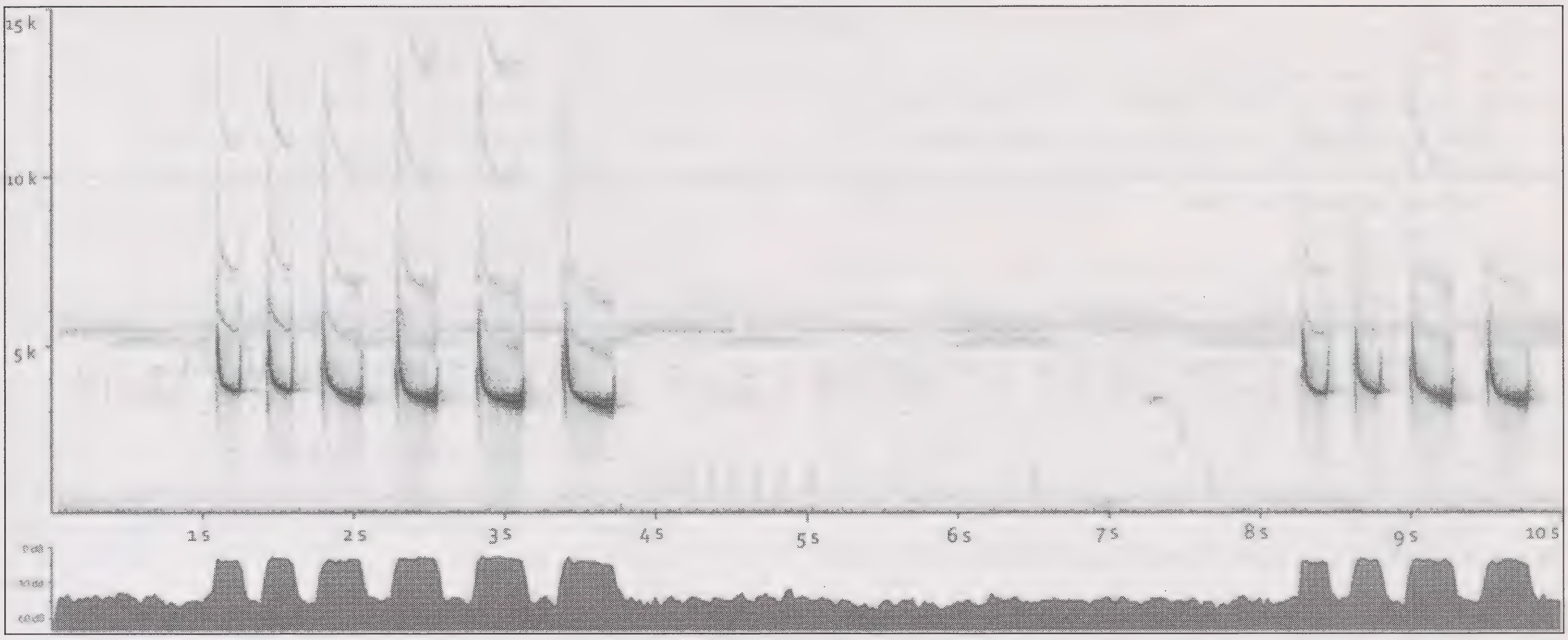
Fig. 4: Rufous-vented Prinia *Prinia burnesii*, Harike, Punjab, India (2012)



Sonogram s1: *Chrysomma altirostre scindicum*: Call



Sonogram s2: *Chrysomma altirostre scindicum*: Song



Sonogram s3: *Chrysomma altirostre griseigularis*: Song

perpendicular position. The brushing sound created by its movements against the reeds is clearly heard even from a distance, and is very helpful in locating the bird. Another similar call consists of notes of *tsk-tew…*, *tsk-tsk-tew…*, or *tew-tew…* with the long last note drawn out and low pitched [see Sonogram s1]. This is mostly followed by a short song described below. The overall tone is weaker and slower than its congener Yellow-eyed Babbler *Chrysomma sinense*.

The second is presumably a flock-territorial call. A short, weak song with a series of 6–8 notes *tew-tew-tew-tew.-tew. chew…*, starting with quick notes and slowing down towards the end, with rapid six notes; the last two notes drawn out and lasting the longest (see Sonogram s2). This song can be heard best in the mornings and is delivered from the tops of grasses in a vertical position with head extended a little and held up. At this time, the bird can be observed for long as it holds its position for at least some time.

CONCLUSION

The survey revealed that Harike Wildlife Sanctuary supports a good population of the *scindicum* subspecies of Jerdon's Babbler. The assemblage of tall, dense, long and unbroken grass stands of *Phragmites-Saccharum-Imperata* and other associated species are important for this bird. The same habitat is shared by the Near Threatened Rufous-vented Prinia *Prinia burnesii*, which is quite common in Harike (Fig. 4). Other birds observed in this habitat were White-tailed Stonechat *Saxicola leucurus* and the White-crowned Penduline Tit *Remiz coronatus*. Jerdon's Babbler and its associated species face threats from grass cutting and burning, grazing by livestock, fragmentation, and drying up of the wetland areas (BirdLife International 2001; Rahmani 2012).

As earlier studies suggest, the bird is probably a resident of the region, and is most likely breeding in the Sanctuary. There is a need to carry out a study throughout the year to determine its seasonality and confirm its breeding status. Such information would be important to assess the population and global status of the species. Overall, Harike WLS being a wetland of great importance and falling on the north-eastern boundary for many rare wintering and vagrant species holds a lot of potential and needs to be further explored and documented.

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This work was possible due to the full support of the Punjab Forest Department. The authors are thankful to all the senior officials of the Forest Department for generous help and support. Thanks to all the range officers, guards, and field staff of Harike Wildlife Sanctuary for providing all help and information. The authors are grateful to Dr. Asad R. Rahmani, Director, BNHS, without whom the project would not have been initiated, for all support and encouragement. The first author specially thanks all the boatmen for taking him around in boats during the survey and assisting in field work; he thanks Mr. Shahnawaz Khan and Ms. Geetanjali Kanwar for their time, concern, and help throughout the survey; the Chandigarh Bird Club, especially Mr. Narbir Kahlon, Mr. Navjit Singh, and Mrs. Rima Dhillon for their continuous support, help, and access to older survey reports; Mr. Shashank Dalvi for his guidance all along. He also thanks Dr. Raju Kasambe, Project Manager, Important Bird Areas Programme and Indian Bird Conservation Network, BNHS.

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A PRELIMINARY OVERVIEW OF THE SUBSPECIES OF RED FOX AND TIBETAN SAND FOX IN THE HIMALAYA, INDIA

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We conducted extensive surveys for the Red Fox *Vulpes vulpes* and Tibetan Sand Fox *V. ferrilata* in the Greater and Trans-Himalaya of north and north-east India between 2008 and 2013, with opportunistic camera trapping done in Kargil, Jammu & Kashmir. In this paper, we provide an update on the distribution of *V. v. griffithii* in the Himalaya, discuss our observations on *V. v. montana*, and support the claim of the occurrence of *V. ferrilata* in India. We also discuss the distribution overlap of *V. v. montana* with *V. v. griffithii* in the Western Himalaya; *V. v. montana* with *V. ferrilata* in the Eastern Himalaya; and *V. v. montana* with Indian Fox *V. bengalensis* in the foothills of the Himalaya.

Key words: *Vulpes*, Himalaya, Red Fox, Tibetan Sand Fox, Indian Fox, distribution

INTRODUCTION

Historically, four species of foxes were recognised from the Indian subcontinent, namely Indian Fox *Vulpes bengalensis*; Red Fox *V. vulpes* (with three subspecies: *V. v. montana*, *V. v. griffithii* and *V. v. pusilla*); Tibetan Sand Fox *V. ferrilata*; and Blanford's Fox *V. cana* (Pocock 1936, 1941; Kumara and Singh 2012). Many of the accounts indicate the occurrence of only two or three species. Prater (2005) documented Indian Fox and all the three subspecies of Red Fox in India. Gurung and Singh (1996) mentioned the occurrence of only two species, namely Indian Fox and Red Fox without any reference to the subspecies of the latter. Menon (2014) listed three species: Indian Fox, Red Fox with three subspecies (*V. v. montana*, *V. v. griffithii*, and *V. v. pusilla*), and Blanford's Fox. The IUCN Canid Action Plan recognises the presence of Indian Fox, Red Fox (with a single subspecies *V. v. montana*), and Tibetan Sand Fox in India (Sillero-Zubiri *et al.* 2004). However, Alfred *et al.* (2002) and recent documentation by Pradhan and Talmale (2012) include all the four species, with two subspecies for Red Fox excluding *V. v. griffithii*. The sighting of Tibetan Sand Fox by Namgail *et al.* (2005) and Chanchani *et al.* (2010) in Ladakh region, Jammu & Kashmir, and Sikkim areas of India support the earlier views of its occurrence within Indian limits.

CITES places *V. bengalensis, V. v. montana, V. v. griffithii* and *V. v. pusilla* in Appendix III. IUCN listed them as species of Least Concern in the Red List of Threatened Species. In this paper, we update the distribution of *V. v. griffithii* in India by providing evidence of its occurrence within Indian limits; support the claim of Chanchani *et al.* (2010) of the presence of *V. ferrilata* in India; and present data on *V. v. montana*. The distribution maps of these species are also provided.

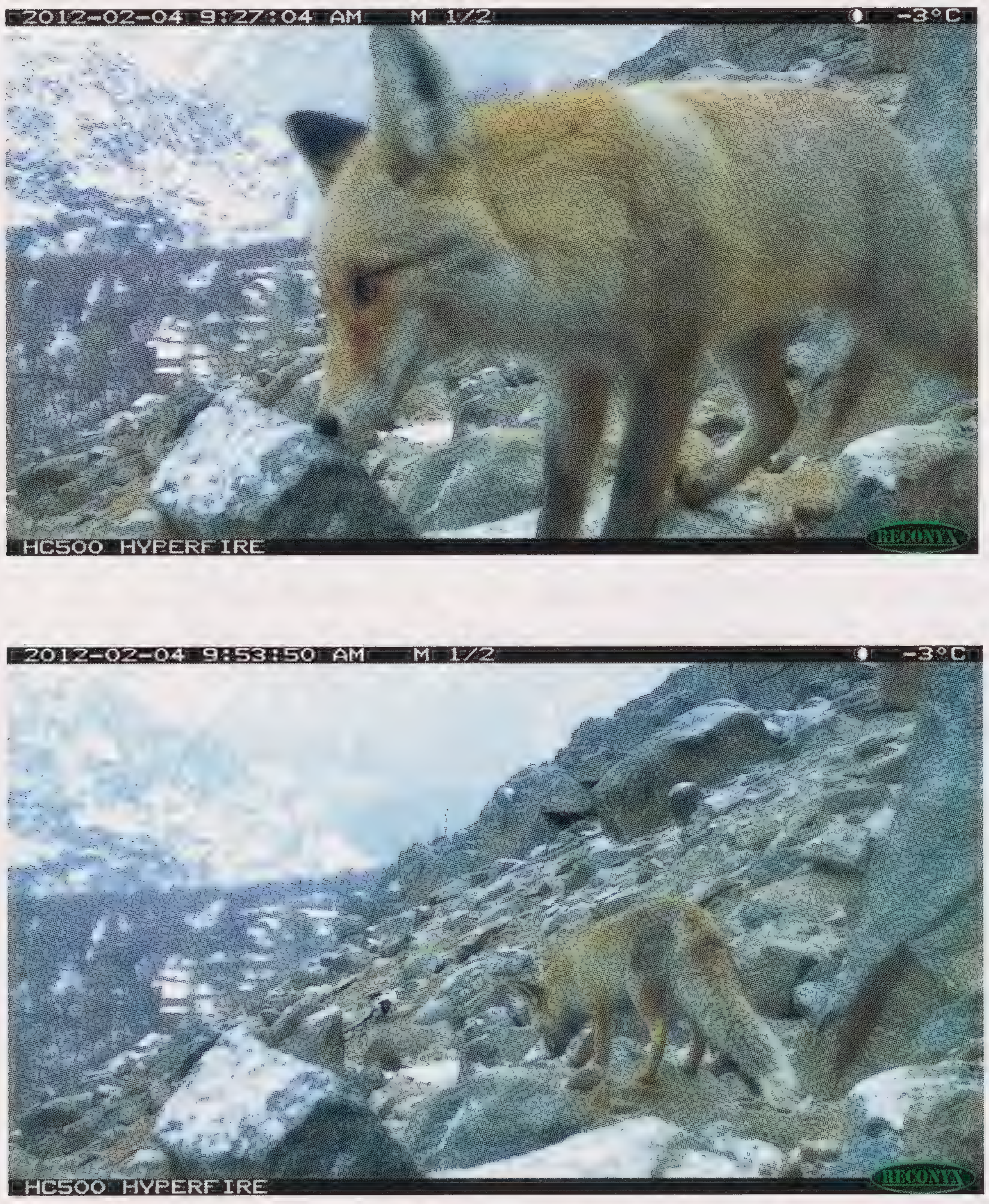
METHODS

The assertions in the present paper are based on surveys and preliminary results of camera trapping. The surveys were carried out as part of an ecological study on Snow Leopard *Panthera uncia*, and the areas surveyed were the Great and Trans-Himalaya of north and north-east India, which were covered from 2008 to 2013. Owing to the topography and remoteness of the area, fieldwork was done during camping expeditions in the different areas for periods of 5–25 days each. More than 3,000 km was traversed on foot in five states of India, namely Jammu & Kashmir (from 2009 to 2013), Himachal Pradesh (2008), Uttarakhand (2008), Sikkim (2012 and 2013), and Arunachal Pradesh (2011 and 2012) covering an altitudinal zone of 2,100 to 5,200 m. Opportunistic camera trapping was done in Kargil, Ladakh in Jammu & Kashmir from 2010 to 2012.

RESULTS AND DISCUSSION

Red Fox *V. v. griffithii*

During the photo trapping sessions, *V. v. griffithii* was camera trapped six times from an area in Kargil close to the border with Pakistan (Figs 1a, b). Additionally, it was sighted on two occasions during the surveys in Kargil. The species was not recorded in areas of the Himalaya of other states covered during the survey. The distribution of *V. v. griffithii* in Jammu & Kashmir, based on the surveys and camera trapping, is given in Fig. 2.


2012-02-04 9:27:04 AM M 1/2 -3°C
HC500 HYPERFIRE
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2012-02-04 9:53:50 AM M 1/2 -3°C
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RECONYX

Figs 1a and b: Camera trap photographs of *V. v. griffithii* from Kargil, Jammu & Kashmir in February 2012

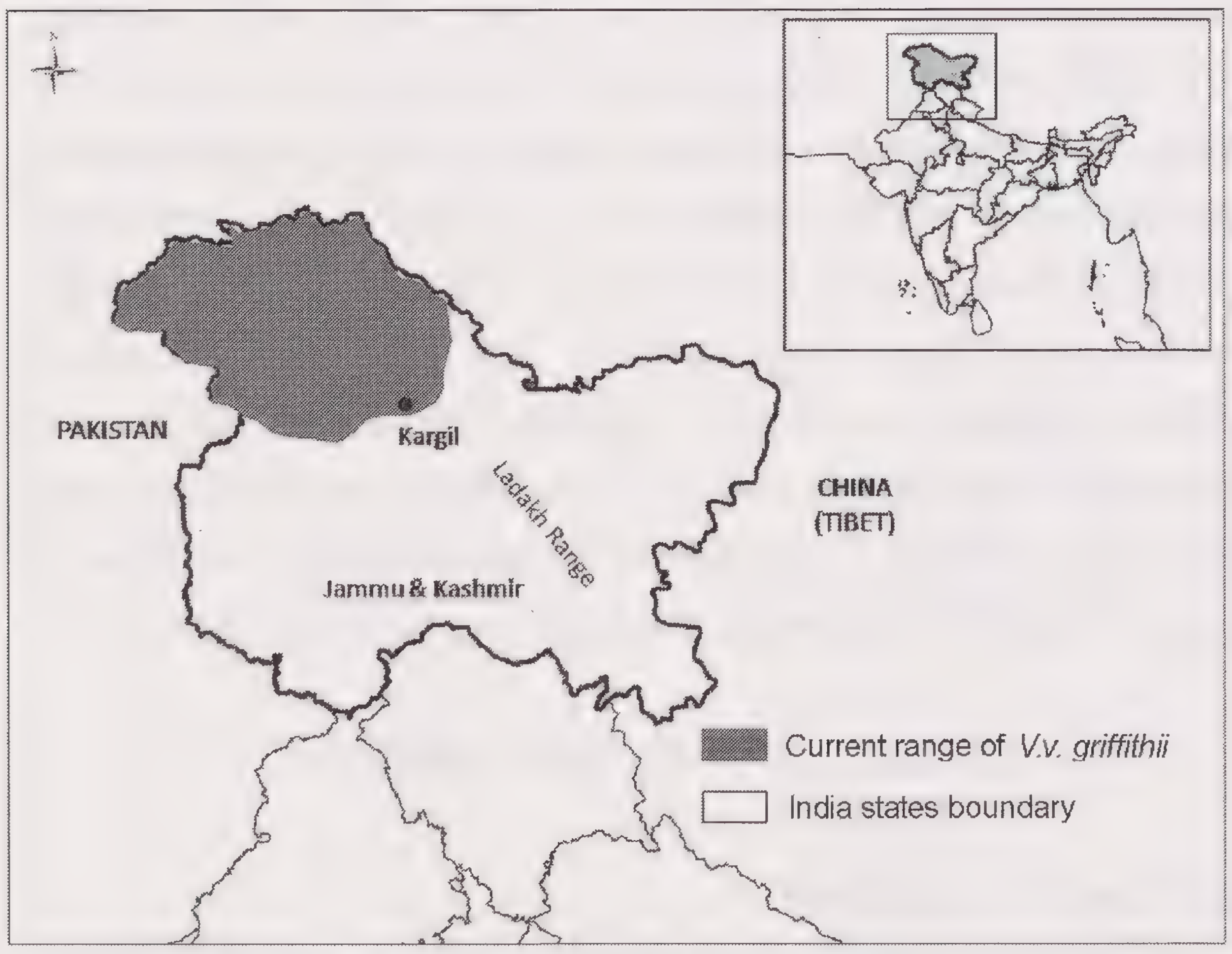

Fig. 2: Distribution of *V. v. griffithii* in Jammu & Kashmir, India (Himalaya)

Roberts (1997) describes *V. v. griffithii* in Pakistan to be smaller than *V. v. montana*, with a thick and luxuriant winter coat. The backs of ears are always jet black and the longer hairs in the dorsal region are banded with white and rusty-orange, giving the fur a very handsome appearance. The inside of the ears are thickly fringed with white hair. The throat and chest region varies from dark grey to black and the dorsal part of the tail has an admixture of black guard hair. The outer fur of the limbs is generally dark grey.

V. v. montana

A total of 109 sightings of *V. v. montana* were obtained during the surveys (Fig. 3). The distribution of *V. v. montana* in the Himalaya, based on the surveys, is given in Fig. 4. Menon (2014) states *V. v. montana* to be the common fox of Ladakh and Himalaya, and describes it as foxy-red in colour, with thick luxuriant under fur during the winters. Ears are

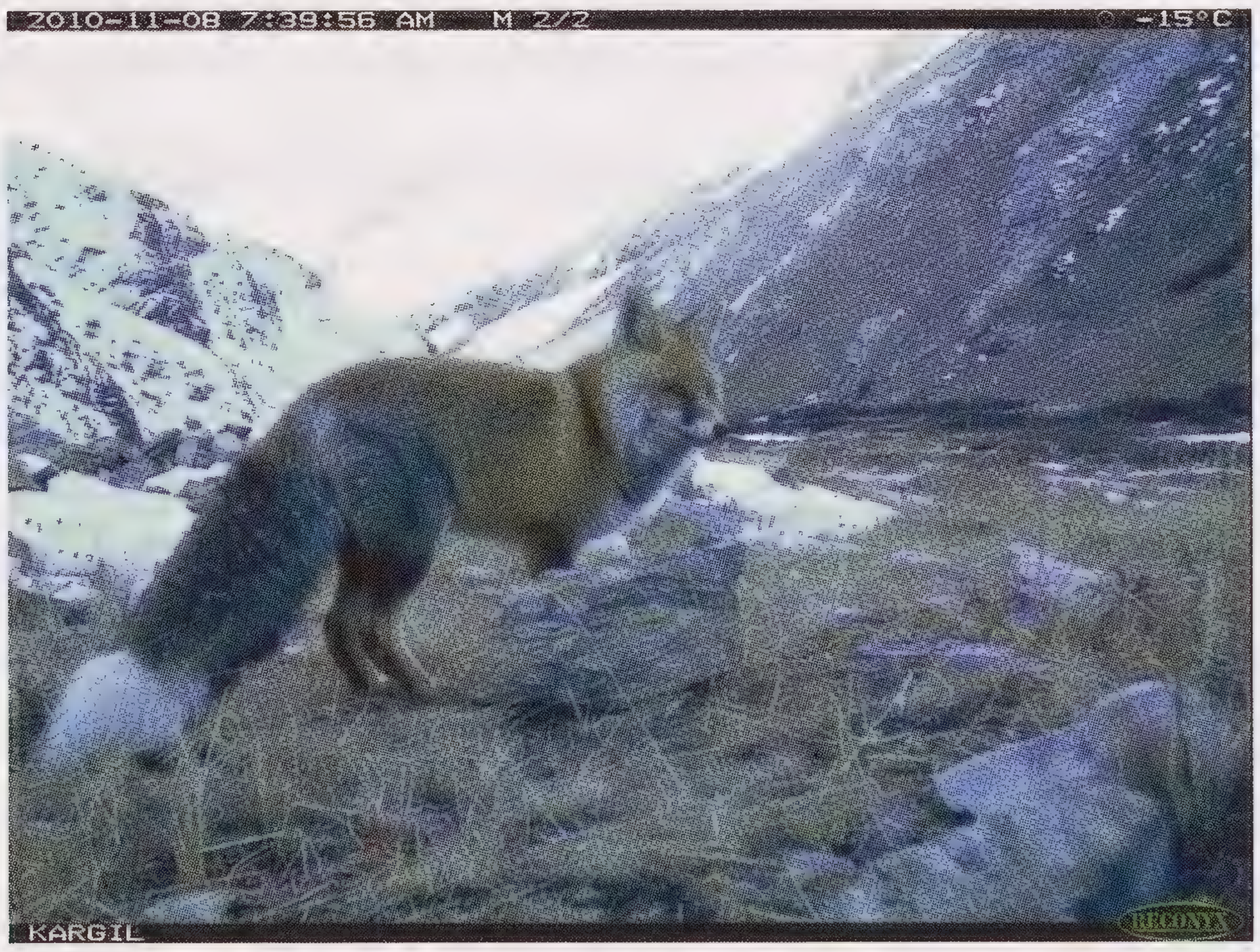

Fig. 3: Camera trap photograph of *V. v. montana* from Kargil, Jammu & Kashmir, in October 2010

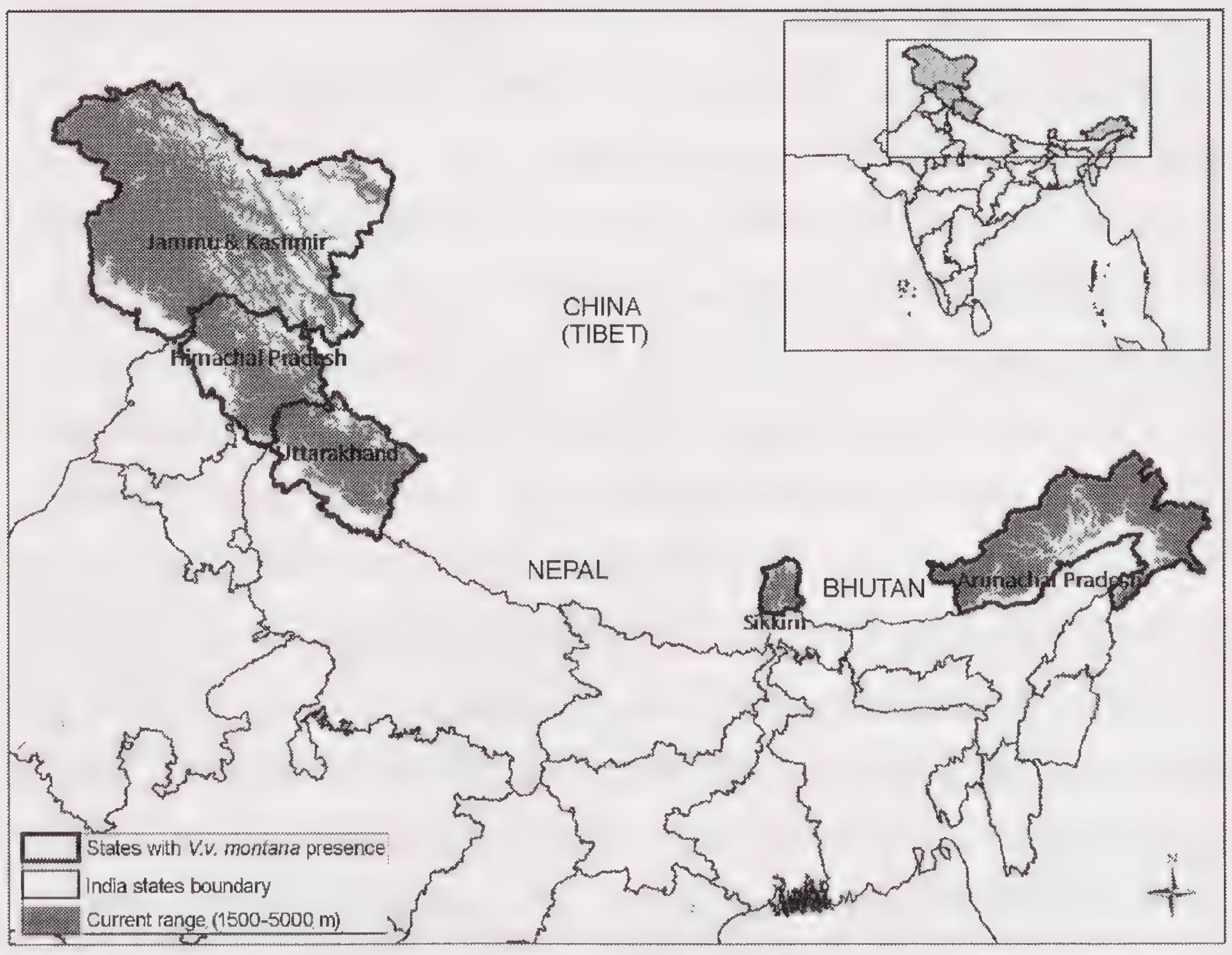

Fig. 4: Distribution of *V. v. montana* in the Himalaya

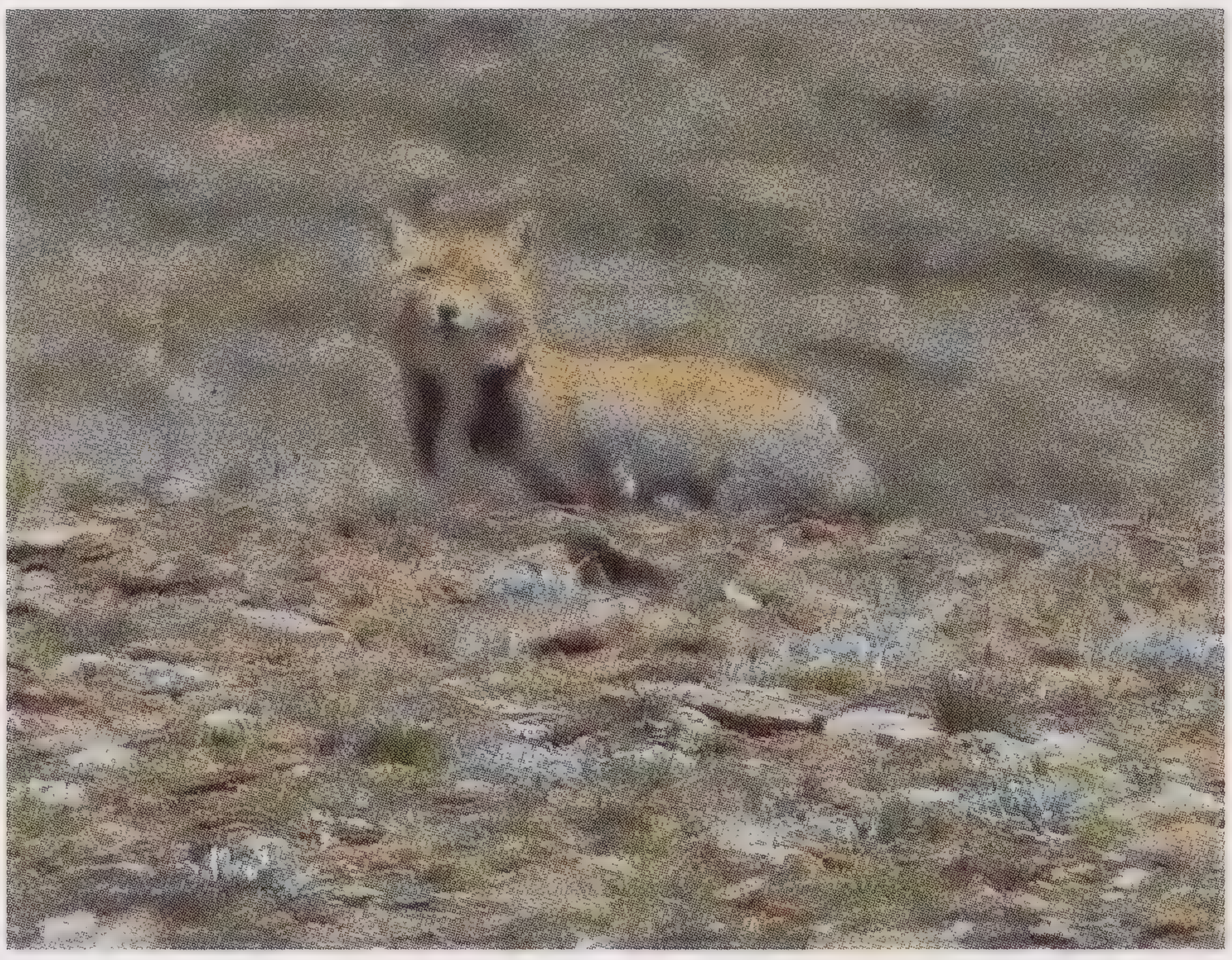

Fig. 5: Tibetan Sand Fox *V. ferrilata* photographed in Tso Lhamo Plateau, Sikkim, in August 2013

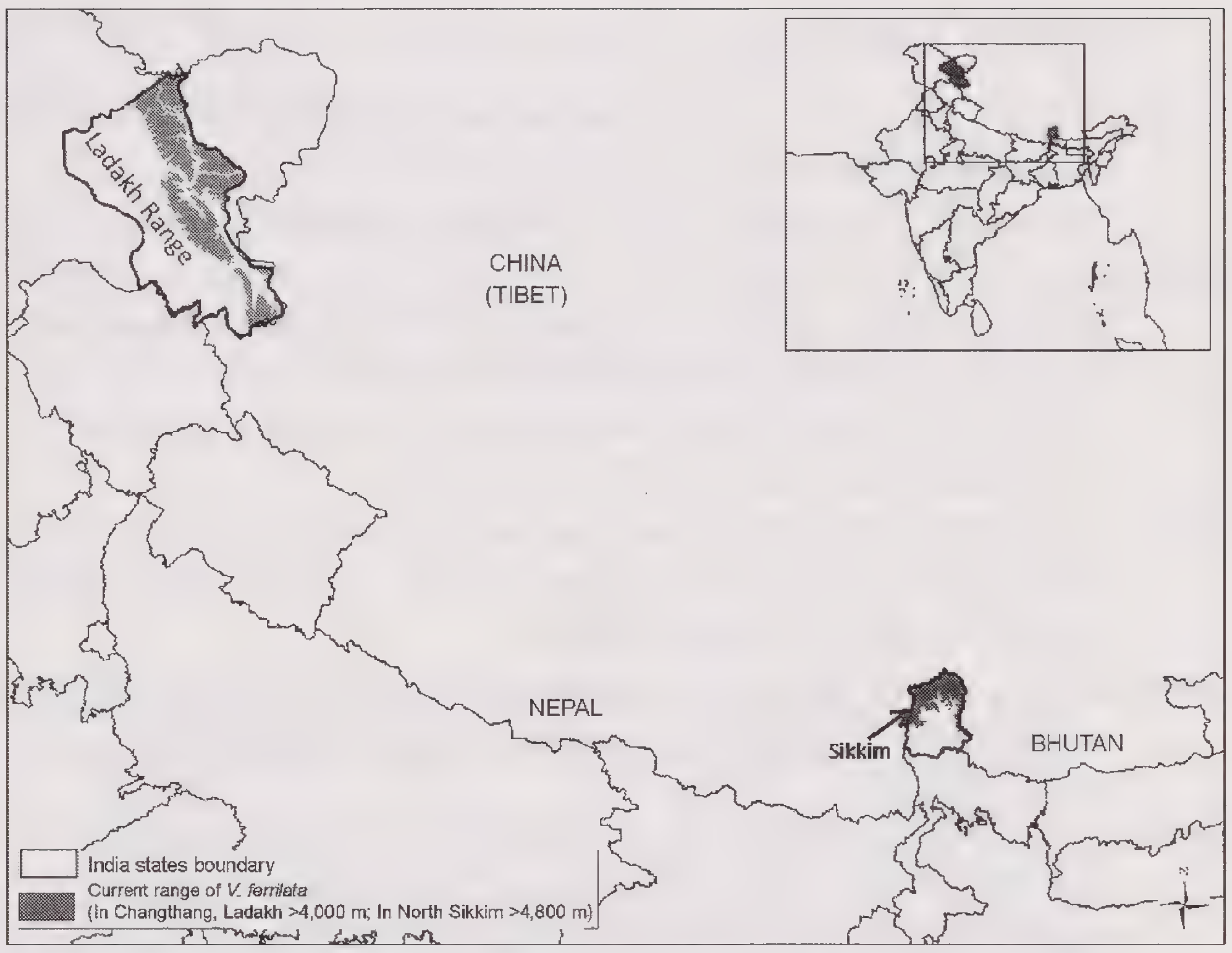
Ladakh Range
CHINA
(TIBET)
NEPAL
Sikkim
BHUTAN
India states boundary
Current range of *V. ferrilata*
(In Changthang, Ladakh >4,000 m; In North Sikkim >4,800 m)
N

Fig. 6: Distribution of *V. ferrilata* in Jammu & Kashmir and Sikkim

large and fringed with white hair. The chest, belly, muzzle, and cheeks have white fur mixed with red.

As both the subspecies (*V. v. montana* and *V. v. griffithii*) overlap and share the same habitats in Kargil, misidentification is quite possible but there are some very prominent characters to distinguish them, which was evident from the camera trap images and sightings obtained of the two species during our study. These are: the winter coat of *V. v. griffithii* is paler than that of *V. v. montana* (Figs 1a, 3); white patches from cheeks to throat are quite prominent in *V. v. montana* compared to *V. v. griffithii* (Figs 1a, 3); and tail is relatively thicker and more bushy in *V. v. montana* than in *V. v. griffithii* (Figs 1b, 3).

Tibetan Sand Fox *Vulpes ferrilata*

We sighted the Tibetan Sand Fox on four occasions in the Tso Lhamo Plateau, North Sikkim (Fig. 5). Chanchani *et al*. (2010) reported it from the same area of Sikkim. Namgail *et al.* (2005) reported it from Changthang, Ladakh, Jammu & Kashmir. We recorded it excavating Pika (*Ochotona*) burrows, as reported by Chanchani *et al*. (2010) in the Tso Lhamo Plateau, and by Schaller and Ginsberg (2004) in the Tibetan Plateau. The distribution of the Tibetan Sand Fox in the Himalaya, based on the surveys, is given in Fig. 6.

Distribution Overlap

We recorded the distribution of *V. v. montana* to overlap with *V. v. griffithii* in Kargil in the Western Himalaya. In the Eastern Himalaya, we sighted *V. ferrilata* in North Sikkim sharing the habitat with *V. v. montana.* Recently, *V. v. montana* has been camera trapped from an elevation as low as 505 m in the foothills of the Western Himalaya (WWF unpubl.), which indicates overlap with the Indian Fox also.

Future Studies

The Red Fox is a well-studied species across the world (Macdonald and Reynolds 2004), but information regarding its distribution, ecology, and subspecies remains rather limited in India. The species in India, which is relatively better studied among the fox species, is the Indian Fox (Home 2005; Johnsingh 1978; Kumara and Singh 2012; Manakadan and Rahmani 2002; Maurya *et al*. 2012; Vanak 2005). There is, therefore, an urgent need to gather baseline information on the status, distribution, and ecology of the other fox species (and subspecies) in India, which is crucial in developing conservation management strategies.

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DORYLAIMID AND TYLENCHID NEMATODES ASSOCIATED WITH BANANA PLANTATIONS IN PASCHIM MEDINIPUR DISTRICT, WEST BENGAL, INDIA

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We recorded 46 species of soil and plant parasitic nematodes belonging to the Orders Dorylaimida and Tylenchida from rhizospheric soil and roots of banana plantations in Paschim Medinipur district, West Bengal from March 2004 to February 2006. Dorylaimida is represented by 29 species under 21 genera of 8 families; 8 species are new to science. Tylenchida is represented by 17 species belonging to 11 genera under 7 families; 4 species are new to science. Among the 46 species, 15 species (13 dorylaimids and 2 tylenchids) were reported for the first time from West Bengal and 5 species (3 dorylaimids and 2 tylenchids) for the first time from India. Sixteen species (12 dorylaimids and 4 tylenchids) were recorded for the first time from the rhizosphere of banana.

Key words: Paschim Medinipur, banana, nematode, dorylaimids, tylenchids

INTRODUCTION

Banana *Musa paradisiaca* is an economically important crop, which has been extensively cultivated in tropical and subtropical regions of the world (Gowen and Queneherve 1990). It is one of the major fruit crops forming an important item in the diet of millions across the globe (Harish and Nanje Gowda 2001). India has emerged as the largest banana producer in the world, with a total production of 23.2 million tonnes per annum from 6.47 lakh ha, which is 32% of the total fruit production of India (Singh 2009). Banana covers 25.73 thousand ha in West Bengal, with total production of 502.11 thousand tonnes per annum. Paschim Medinipur is one of the major banana growing districts of West Bengal.

Nematodes constitute one of the major pests of banana. Tylenchids – plant parasitic nematodes – are a major constraint in banana production and yields losses (Sundararaju 2006). Dorylaimids, besides causing direct root damage, act as causal agents and vectors, transmitting various soil-borne bacterial, fungal, and viral pathogens to this important crop. Thus, members of the Orders Dorylaimida and Tylenchida have direct or indirect impacts on this valuable fruit crop. In this context, an investigation was carried out on the soil and plant parasitic nematodes of the Orders Dorylaimida and Tylenchida associated with banana in Paschim Medinipur district of West Bengal, the findings of which could be useful in agriculture.

MATERIAL AND METHODS

The study was carried out in Paschim Medinipur district (22° 40' 37" N; 87° 38' 72" E), West Bengal (Fig. 1), from March 2004 to February 2006. Soil and root samples were collected randomly from banana fields cultivated with Kanthali variety from all the 29 blocks of the district in two seasons, namely wet season (July/August) and dry season (December/January). During each season, four soil and root samples were collected from four banana fields in each of the 29 blocks. Thus, a total of 464 samples each of soil and root were collected. Soil sample (250 gm) was taken with the help of a scooping hand-shovel from the rhizosphere, up to a depth of 20 cm, at a distance of 25 cm from the banana orchard.

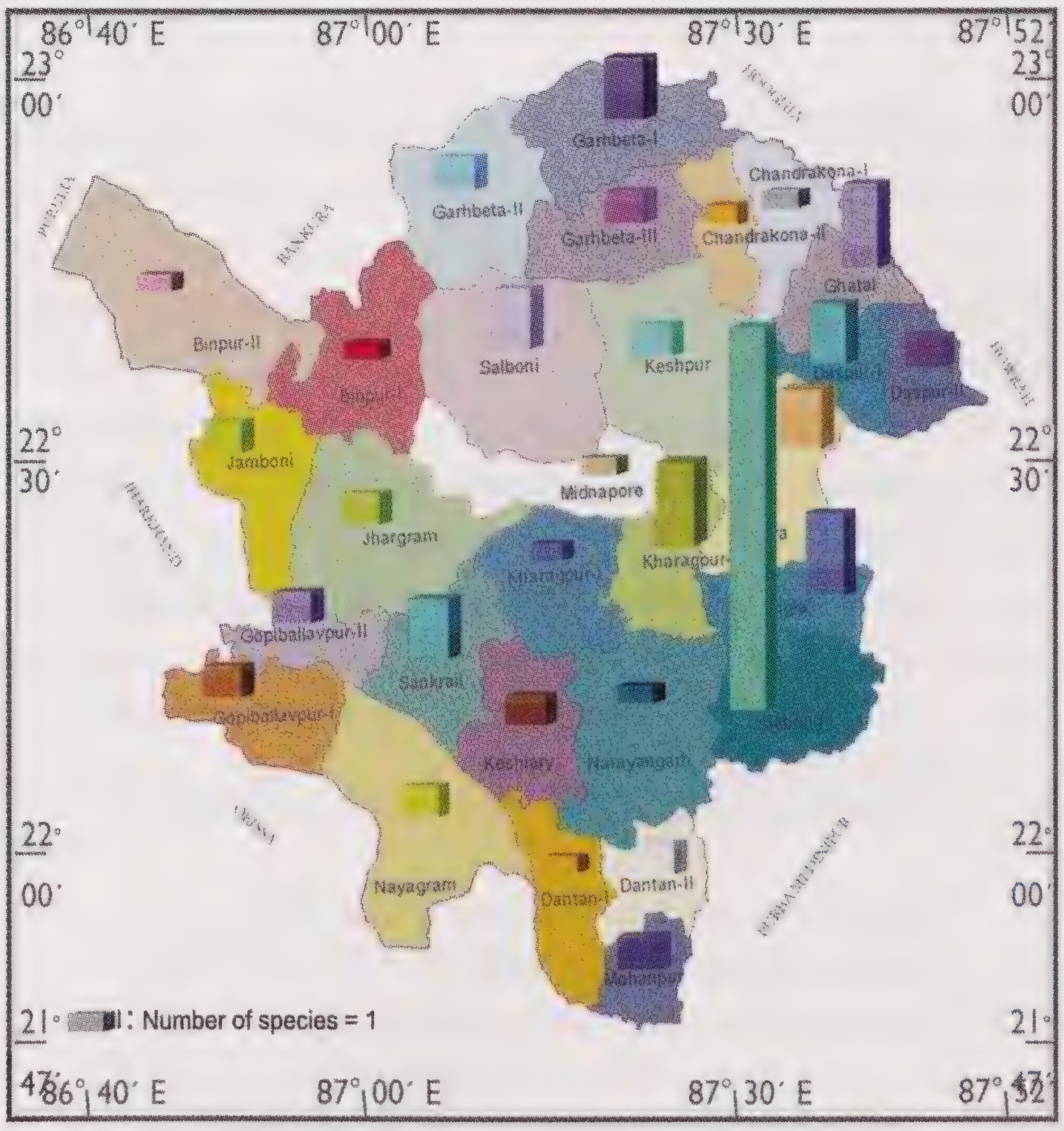

Fig.1: Map of Paschim Medinipur district, showing the species richness of dorylaimid and tylenchid nematodes in banana plantations in the 29 blocks of the district

Table 1: Records of nematodes in the banana plantations of Paschim Medinipur district (March 2004–February 2006)

Sl. No.	Species	Block	Village
1.	*Dorylaimus innovatus* Jana and Baqri 1982	Daspur-2	Kashimpur
2.	*D. neominimus* Gantait *et al.* 2009a	Sankrail	Dumuria
		Sabang	Muraricha k
3.	*Mesodorylaimus sushili* Gantait *et al.* 2007a	Debra	Balichak
4.	*Prodorylaimus jihuai* Ahmad and Ahmad 2001	Jambani	Alampur
5.	*P. sukuli* Baksi and Baqri 1985	Sabang	Murarichak
		Daspur-1	Sagarpur, Uttarbarh
6.	*Laimydorus minutus* Gantait *et al.* 2011a	Kharagpur-2	Amlichak
7.	*L. siddiqii* Baqri and Jana 1982	Sabang	Murarichak
		Pingla	Maligram
8.	*Thornenema garhwalicum* Srivastava *et al.* 2000	Gopiballavpur-2	Jahanpur
9.	*Lagenonema thornei* Gantait *et al.* 2010a	Mohanpur	Borai
10.	*Aporcelaimellus conicaudatus* (Altherr 1953) Monteiro 1970	Garhbeta-3	Damodarpur
11.	*A. heynsi* Baqri and Jairajpuri 1968	Ghatal	Lakshmanpur
		Pingla	Jamna, Jalchak
		Daspur-1	Sitapurh
12.	*A. subhasi* Gantait *et al.* 2006	Sabang	Murarichak
13.	*Makatinus siddiqii* Gantait *et al.* 2011b	Sankrail	Dumuria
14.	*Sectonema procta* Jairajpuri and Baqri 1966	Keshpur	Mamudpur, Anandapur
15.	*Labronema glandosum* Rahaman *et al.* 1986	Gopiballavpur-1	Lutijhuri
16.	*Crassolabium garhwalensis* (Ahmad *et al.* 1986) Peña-Santiago & Ciobanu 2008	Sabang	Murarichak
		Jambani	Hijli
17.	*Discolaimus dhanachandi* Gantait *et al.* 2009b	Sabang	Laro
18.	*Discolaimium parweiji* Siddiqi 2003	Dantan-1	Sonkania
19.	*Discolaimoides teres* Khan and Laha 1982	Pingla	Bagnabarh
		Debra	Loada
		Kharagpur-1	Narayanpur
20.	*Oriverutus lobatus* Siddiqi 1971	Sabang	Murarichak
		Dantan-2	Khandrui
		Jhargram	Manikpara
21.	*O. parangulatus* Baqri 1991	Chandrakona-1	Basulia
22.	*Paractinolaimus aruprus* Khan *et al.* 1994	Sabang	Murarichak
		Daspur-2	Rajnagar
23.	*P. shamimi* Gantait *et al.* 2006	Garhbeta-1	Jamdova
24.	*Tylencholaimus* (*Tylencholaimus*) *obscurus* Jairajpuri 1965	Nayagram	Dokra
25.	*T.* (*Opisthotylencholaimus*) *pakistanensis* Timm 1964	Garhbeta-2	Gowaltorh
26.	*Promumtazium elongatum* Ahmad and Jairajpuri 1984	Sabang	Murarichak
		Binrur-2	Dumuria
27.	*Dorylaimoides* (*Longidorylaimoides*) *filicaudatus* Jana and Baqri 1991	Chandrakona-2	Raghunathpur
		Ghatal	Gangadaspur
28.	*Aquatides aquaticus* (Thorne 1930) Thorne 1974	Kharagpur-2	Madpur
		Narayangarh	Radhanagar, Ranipur
29.	*Laevides laevis* (Thorne 1939) Thorne 1974	Ghatal	Gangadaspur
30.	*Polenchus shamimi* Baqri 1991	Salbani	Pathardaha
31.	*Nothotylenchus hexaglyphus* Khan & Siddiqi 1968	Garhbeta-2	Amlasuli
		Keshiwari	Danapur
32.	*Hoplolaimus* (*Basirolaimus*) *indicus* Sher 1963	Sabang	Murarichak
		Jhargram	Ghoradhara

Table 1: Records of nematodes in the banana plantations of Paschim Medinipur district (March 2004–February 2006) (*contd.*)

Sl. No.	Species	Block	Village
33.	*Helicotylenchus crenacauda* Sher 1966	Sabang	Murarichak
		Mohanpur	Kusumda
		Pingla	Maligram, Jamna
		Salbani	Pathardaha
34.	*H. dihystera* Sher 1961	Garhbeta-1	Amlasuli
35.	*H. hydrophilus* Sher 1966	Keshpur	Amalda
36.	*H. medinipurensis* Gantait *et al.* 2007b	Kesiwari	Srirampur
		Debra	Satyapur
37.	*H. wasimi* Gantait *et al.* 2010b	Salbani	Pathardaha
38.	*Rotylenchus* (*Rotylenchus*) *alii* Maqbool and Shahina 1986	Gopiballavpur-2	Kajla
		Nayagram	Jugisol
39.	*Varotylus jairajpurii* Gantait *et al.* 2011c	Kharagpur-2	Amlichak
40.	*Rotylenchulus reniformis* Linford and Oliveira 1940	Sabang	Murarichak, Uchitpur
		Dantan-2	Dhaneswarpur
41.	*Pratylenchus coffeae* (Zimmermann 1898) Filipjev and Schuurmans Stekhoven 1941	Sabang	Murarichak
		Khargpur-2	Dhitpur
		Garhbeta-3	Chandmura
42.	*Hirschmanniella gracilis* (De man, 1880) Luc and Goodey 1964	Sabang	Murarichak, Dubrajpur
		Daspur-1	Sagarpur, Kamalpur
43.	*H. mannai* Gantait *et al.* 2007b	Gopibalavpur-1	Balarampur
44.	*Meloidogyne incognita* (Kofoid and White, 1919) Chitwood 1949	Sabang	Murarichak
		Ghatal	Mandaria
45.	*Tylenchorhynchus coffeae* Siddiqi and Basir 1959	Sabang	Murarichak
		Medinipur	Depara
		Sankrail	Laudaha
46.	*T. mashhoodi* Siddiqi and Basir 1959	Binpur-1	Shilda
		Garhbeta-1	Amlagorh

Root sample (5 gm) was taken from the orchard. Nematodes were extracted from the soil by Cobb's sieving technique (Cobb 1918) and from the root by Mechanical maceration technique (Reddy 1983), decanting method by Modified Baermann's funnel technique (Christie and Perry 1951), processed by Seinhorst's slow dehydration method (Seinhorst 1959). Dehydrated nematodes were mounted permanently on glass slides and identified up to species level following the keys of Jairajpuri and Ahmad (1992) for Order Dorylaimida and Siddiqi (2000) for Order Tylenchida. All the specimens were deposited in the National Zoological Collections of the Zoological Survey of India, Kolkata, West Bengal, India.

RESULTS AND DISCUSSION

A total of 46 species of soil and plant parasitic nematodes belonging to 32 genera of 15 families under the Orders Dorylaimida and Tylenchida were recorded from different localities of Paschim Medinipur district, West Bengal, India. Of these, 29 species were of Order Dorylaimida belonging to 21 genera of 8 families. Order Tylenchida was represented by 17 species belonging to 11 genera under 7 families. Amongst these, 8 species of dorylaimids and 4 species of tylenchids were new to science and have already been published (Gantait *et al.* 2006, 2007a,b, 2009 a,b, 2010 a,b, 2011a,b,c). Fifteen species (13 dorylaimids and 2 tylenchids) were reported for the first time from West Bengal and 5 species (3 dorylaimids and 2 tylenchids) for the first time from India. Sixteen species (12 dorylaimids and 4 tylenchids) were recorded for the first time from the rhizosphere of banana. A systematic list of the species is given below.

Systematic list of the nematode taxa
Class: Nematoda
Order: Dorylaimida Pearse, 1942
Suborder: Dorylaimina Pearse, 1936
Superfamily: Dorylaimoidea de Man, 1876
Family: Dorylaimidae de Man, 1876

Subfamily: Dorylaiminae de Man, 1876
1. #_Dorylaimus innovatus_ Jana and Baqri, 1982
2. $ _D. neominimus_ Gantait, Bhattacharya and Chatterjee, 2009a

Subfamily: Laimydorinae Andrássy, 1969
3. $ _Mesodorylaimus sushili_ Gantait, Bhattacharya and Chatterjee, 2007a
4. **#_Prodorylaimus jihuai_ Ahmad and Ahmad, 2001
5. #_P. sukuli_ Baksi and Baqri, 1985
6. $ _Laimydorus minutus_ Gantait, Bhattacharya and Chatterjee, 2011a
7. _L. siddiqii_ Baqri and Jana, 1982

Subfamily: Thornenematinae Siddiqi, 1969
8. *#_Thornenema garhwalicum_ Srivastava, Rawat and Ahmad, 2000
9. $ _Lagenonema thornei_ Gantait, Bhattacharya and Chatterjee, 2010a

Family: Aporcelaimidae Heyns, 1965
Subfamily: Aporcelaiminae Heyns, 1965
10. **#_Aporcelaimellus conicaudatus_ (Altherr, 1953) Monteiro, 1970
11. _A. heynsi_ Baqri and Jairajpuri, 1968
12. $ _A. subhasi_ Gantait, Bhattacharya and Chatterjee, 2006
13. $ _Makatinus siddiqii_ Gantait, Bhattacharya and Chatterjee, 2011b

Subfamily: Sectonematinae Siddiqi, 1969
14. *#_Sectonema procta_ Jairajpuri and Baqri, 1966

Family: Qudsianematidae Jairajpuri, 1965
Subfamily: Qudsianematinae Jairajpuri, 1965
15. *_Labronema glandosum_ Rahman, Jairajpuri, Ahmad and Ahmad, 1986
16. *#_Crassolabium garhwaliensis_ (Ahmad _et al._ 1986) Peña-Santiago & Ciobanu, 2008

Subfamily: Discolaiminae Siddiqi, 1969
17. $ _Discolaimus dhanachandi_ Gantait, Bhattacharya and Chatterjee, 2009b
18. **#_Discolaimium parweizi_ Siddiqi, 2003
19. *#_Discolaimoides teres_ Khan and Laha, 1982

Family: Nordiidae Jairajpuri and Siddiqi, 1964
Subfamily: Actinolaimoidinae Jairajpuri and Ahmad, 1992
20. *_Oriverutus lobatus_ Siddiqi, 1971
21. *#_O. parangulatus_ Baqri, 1991

Superfamily: Actinolaimoidea Thorne, 1939
Family: Actinolaimidae Thorne, 1939
Subfamily: Paractinolaiminae Thorne, 1967
22. *_Paractinolaimus aruprus_ Khan, Ahmad and Jairajpuri, 1994
23. $ _P. shamimi_ Gantait, Bhattacharya and Chatterjee, 2006

Superfamily: Tylencholaimoidea Filipjev, 1934
Family: Tylencholaimidae Filipjev, 1934
Subfamily: Tylencholaiminae Filipjev, 1934
24. *_Tylencholaimus_ (_Tylencholaimus_) _obscurus_ Jairajpuri, 1965
25. *_T._ (_Opisthotylencholaimus_) _pakistanensis_ Timm, 1964

Subfamily: Mumtaziinae Andrássy, 1976
26. *#_Promumtazium elongatum_ Ahmad and Jairajpuri, 1984

Family: Mydonomidae Thorne, 1964
Subfamily: Mydonominae Thorne, 1964
27. #_Dorylaimoides_ (_Longidorylaimoides_) _filicaudatus_ Jana and Baqri, 1991

Suborder: Nygolymina Ahmad and Jairajpuri, 1979
Superfamily: Nygolaimoidea Thorne, 1935
Family: Nygolaimidae Thorne, 1935
Subfamily: Nygolaiminae Thorne, 1935
28. *_Aquatides aquaticus_ (Thorne, 1930) Thorne, 1974
29. *_Laevides laevis_ (Thorne, 1939) Thorne, 1974

Order: Tylenchida Thorne, 1949
Suborder: Tylenchina Chitwood in Chitwood and Chitwood, 1950
Superfamily: Tylenchoidea Örley, 1880
Family: Tylenchidae Örley, 1880
Subfamily: Tylenchinae Örley, 1880
30. *#_Polenchus shamimi_ Baqri, 1991

Superfamily: Anguinoidea Nicoll, 1935
Family: Anguinidae Nicoll, 1935
Subfamily: Anguininae Nicoll, 1935
31. *#_Nothotylenchus hexaglyphus_ Khan and Siddiqi, 1968

Superfamily: Hoplolaimoidea (Filipjev, 1934) Paramonov, 1967
Family: Hoplolaimidae (Filipjev, 1934) Wieser, 1953
Subfamily: Hoplolaiminae Filipjev, 1934
32. _Hoplolaimus_ (_Basirolaimus_) _indicus_ Sher, 1963

Subfamily: Rotylenchoidinae Whitehead, 1958
33. *Helicotylenchus crenacauda* Sher, 1966
34. *H. dihystera* Sher, 1961
35. **#*H. hydrophilus* Sher, 1966
36. $ *H. medinipurensis* Gantait, Bhattacharya and Chatterjee, 2007b
37. $ *H. wasimi* Gantait, Bhattacharya and Chatterjee, 2010b
38. **#*Rotylenchus* (*Rotylenchus*) *alii* Maqbool and Shahina, 1986
39. $ *Varotylus jairajpurii* Gantait, Bhattacharya and Chatterjee, 2011c

Family: Rotylenchulidae (Husain and Khan, 1967) Husain, 1976
Subfamily: Rotylenchulinae Husain and Khan, 1967
40. *Rotylenchulus reniformis* Linford and Oliveira, 1940

Family: Pratylenchidae (Thorne, 1949) Siddiqi, 1963
Subfamily: Pratylenchinae Thorne, 1949
41. *Pratylenchus coffeae* (Zimmermann, 1898) Filipjev and Sc Stekhoven, 1941

Subfamily: Hirschmanniellinae Fotedar and Handoo, 1978
42. *Hirschmanniella gracilis* (de man, 1880) Luc and Goodey, 1964
43. $ *H. mannai* Gantait, Bhattacharya and Chatterjee, 2007b

Family: Meloidogynidae (Skarbilovich, 1959) Wouts, 1973
Subfamily: Meloidogyninae Skarbilovich, 1959
44. *Meloidogyne incognita* (Kofoid and White, 1919) Chitwood, 1949

Superfamily: Dolichodoroidea (Chitwood and Chitwood, 1950) Siddiqi, 1986
Family: Telotylenchidae Siddiqi, 1960
Subfamily: Telotylenchinae Siddiqi, 1960
45. *Tylenchorhynchus coffeae* Siddiqi and Basir, 1959
46. *T. mashhoodi* Siddiqi and Basir, 1959

$ = New to Science
* = First report from West Bengal
** = First report from India
# = First report from banana

The number of dorylaimid species (29) recorded were relatively more than tylenchids. The lower species richness in tylenchids is probably because they are typically plant parasitic in nature, and hence cannot survive long when the fields are bare. Conversely, dorylaimids are accustomed to many life modes, and can survive even when the fields are fallow (Ghosh and Manna 2008), which puts the dorylaimids ahead of tylenchids in respect of survival capacity (Chatterjee and Gantait 2000). Having various modes of life not only ensures easier food supply but reduces intra-specific competition significantly (Chatterjee and Sen 1998). Among the 32 nematode genera and the 11 genera of tylenchids recorded, the genus *Helicotylenchus* had the maximum number of species. This may be due to its known wide range of hosts (Taylor 1960, 1961) of more than 200 host plants (Chatterjee and Gantait 2000). A parasitic genus having rigid host specificity (*viz*., having one or very few host plants) would get less chances to radiate in different phyletic lines to ultimately produce a variety of species (i.e. speciation), compared to a plant parasitic genus that is polyphagous in nature (i.e. with a wide range of host species) (Siddiqi 1979). Chatterjee and Sen (1998) revealed that polyphagous genera tend to have higher number of species.

Most of the species recorded were represented by females, males being relatively rare. Similar observations have been made in some other lower invertebrate groups like insects (Suomalainen 1940, Vandel 1931). This is mainly due to the uncertainty of females encountering males at the time of breeding, which compels them to adopt parthenogenetic reproduction (Vandel 1931). This should be more true for nematodes because they live in soil habitat and have poor mobility through the soil granules and particles, and hence are more uncertain to find mates (Siddiqi 1983). This may have led them to adopt parthenogenesis, resulting in an abundance of females compared to males.

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SIGNIFICANCE OF PHALLIC COMPLEX IN THE CLASSIFICATION OF INDIAN PYRGOMORPHIDAE (ORTHOPTERA: PYRGOMORPHOIDEA)

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A study of phallic complex – internal genitalic structures in males – was undertaken in twelve species of grasshoppers, representing six genera under four tribes of the family Pyrgomorphidae. The study revealed that the shape of epiphallus, presence and absence of ancorae, direction of lophi, and comparative size of central membrane of cingulum are stable characters in the identification, and are of significance at each and every taxonomic level. The species studied are arranged under their respective tribes, along with keys to their tribes and genera.

Key words: Pyrgomorphidae, phallic complex, epiphallus, classification

INTRODUCTION

Pyrgomorphidae is a family of grasshoppers of the order Orthoptera and comes under the suborder Caelifera, commonly known as gaudy grasshoppers. It is the only family in the superfamily Pyrgomorphoidea. Pyrgomorphidae is closely related to the family Acrididae, under which earlier workers had placed it as subfamily Pyrgomorphinae. Later, its status was raised to the family level (Pyrgomorphidae) under the superfamily Acridoidea. Currently, it is treated as the only family under Pyrgomorphoidea (Flook *et al.* 1999). Pyrgomorphidae are represented in all the tropical and subtropical parts of the world by a large number of genera. They are characterised by the presence of acutely conical head, fastigial furrow, prosternal process; elytra and wings fully developed, reduced or absent; tympanum normally present; lower basal lobe of hind femur normally longer than upper lobe; ectophallus differentiated; cingulum capsule-like; valves of penis paired, undivided; spermatophore sac in dorsal position; epiphallus bridge-shaped with dorsolateral appendices; ancorae absent; lophi hook-like; oval sclerites absent (Fig. 1).

The system of classifying grasshoppers by earlier workers was mainly based on easily recognisable externally visible characters. Another distinguishing character is the internal genitalic structures in males, termed as phallic complex. Epiphallus is a part of the phallic complex. It is a strongly sclerotised and complex structure lying on the cingulum. Roberts (1941) made a comparative study of phallic complex in different subfamilies of Acrididae. Dirsh (1956) made taxonomic studies on phallic complex in Acridoidea, and a comparative study of epiphallus in various families and subfamilies of Acridoidea. Ajaili and Usmani (1990) have shown the taxonomic significance of epiphallus in some Libyan species of Acridoidea. Kevan *et al.* (1972, 1974) made extensive studies on phallic complex in all known genera of Pyrgomorphidae in order to establish the relationship existing between them. Recently Usmani *et al.* (2011) explained the

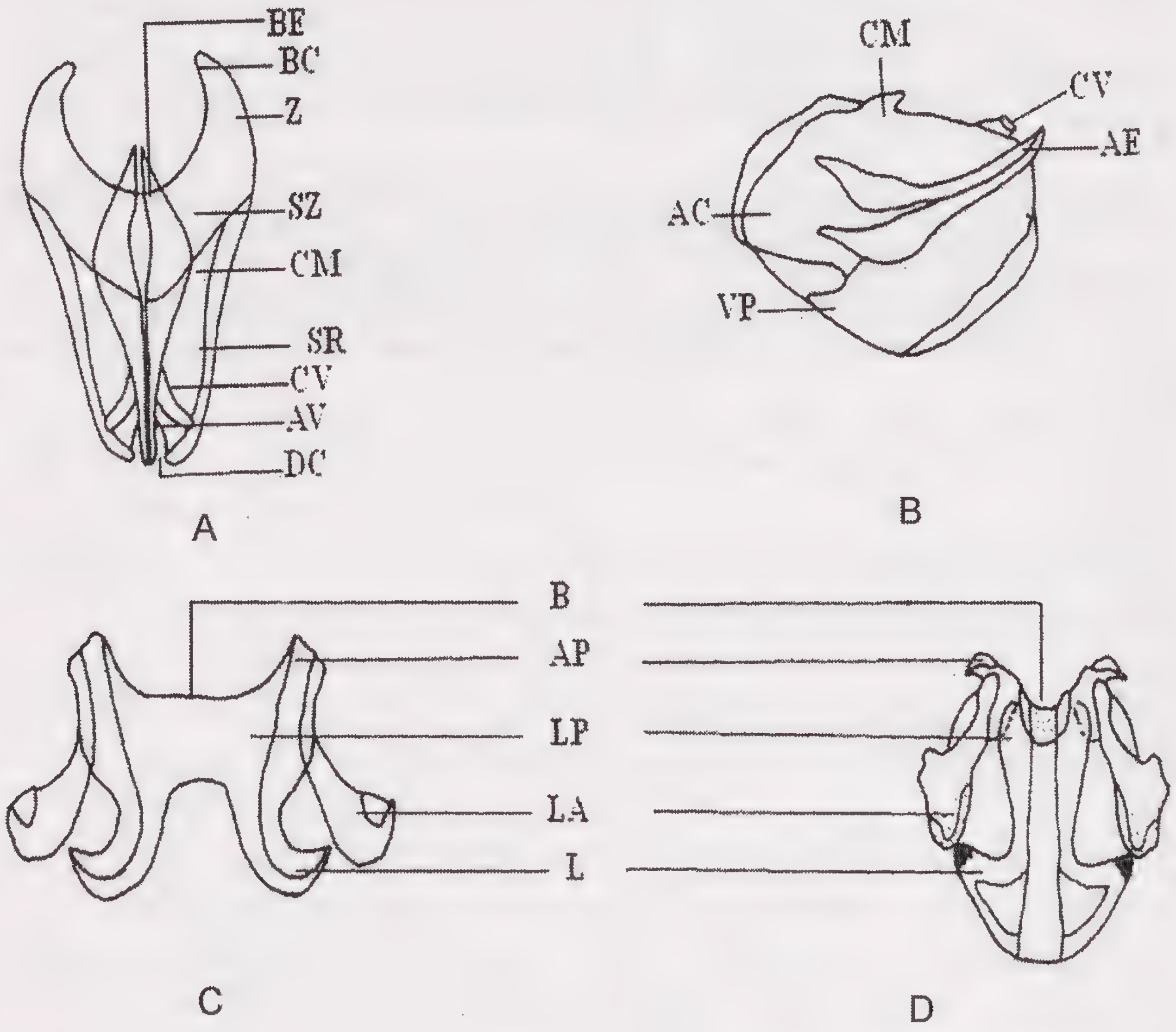

Fig. 1: A. Dorsal view of Phallus, B. Lateral view of Phallus, C. Bridge-shaped Epiphallus, D. Anchor-shaped Epiphallus

List of abbreviations: [Adopted from Dirsh terminology (1956)]
AC = apodemal plate of cingulum; AE = aedeagus; AP = anterior projection; AV = aedeagal valve; B = bridge of epiphallus; BC = basal thickening of cingulum; BE = basal emargination of cingulum; CM = central membrane of ectophallus; CV = valve of cingulum; DC = dorsal cleft of cingulum; L = lophus; LP = lateral plate of epiphallus; LA = lateral appendices; SZ = suprazygomal plate of cingulum; VP = ventral process of cingulum; Z = zygoma of cingulum

taxonomic significance of phallic complex in ten species of Acridoidea.

In this paper, we discuss the phallic complex in twelve species of Pyrgomorphidae collected from various localities of different states of India, namely Punjab, Uttar Pradesh, Rajasthan, Haryana, Himachal Pradesh, and Jammu & Kashmir during 2009 to 2012. These species were also studied through conventional taxonomy.

METHODOLOGY

Adults of both sexes of twelve species of grasshoppers were collected from different localities, and their general taxonomy studied. In males, the terminal part of the abdomen was cut off and boiled in 10% potassium hydroxide till the material became transparent (usually about 10 minutes) to remove unsclerotized and non-chitinous tissues. It was then thoroughly washed under tap water for complete removal of KOH and examined in 70 percent ethyl alcohol on a cavity slide. Later, every specimen was dissected under a binocular microscope with the help of fine needles to separate various components of the phallic complex, namely the epiphallus and phallus. The normal process of dehydration was adopted, and clearing was done in clove oil. The genital structures were mounted separately on cavity slides in Canada balsam. The phallic complex was mounted in Canada balsam on a cavity slide oriented to the required position without cover glass. The slides were kept in a slide drier at a temperature of *c*. 40°C for about a week to dry completely. These permanent slides were examined under the microscope to study the genital structures. Drawings were initially made with the help of Camera Lucida. Details were filled in after studying the slide under a conventional microscope.

RESULTS

TAXONOMIC ACCOUNT

Family Pyrgomorphidae Brunner Von Wattenwyl, 1882

KEY TO TRIBES OF THE FAMILY PYRGOMORPHIDAE BRUNNERVON WATTENWYL, 1882

1. Body never depressed; prosternum without reflexed, collar-like anterior margin 2

— Body depressed; pronotum with reflexed, collar-like anterior margin; tegmina with small nodules on main veins; antennae cylindrical; Epiphallus bridge-shaped with strongly curved lophi .... Chrotogonini Bolivar, 1904

2. Body small, never large and heavy; tegmina and hind wing usually fully developed 3

— Body large and heavy; antennae filiform with basal segments as long as wide; pronotum with metazoan convex, much widened distad, posterior margin somewhat rounded; tegmina and hind wing well-developed; Epiphallus bridge-shaped with large hook-like lophi and anterior projection .... Poekilocerini Burmeister, 1840

3. Tegmina if fully developed never tapered and pointed; epiphallus bridge-shaped with excurved anterior margin and lophi with curved hook .... Pyrgomorphini Brunner, 1882

— Tegmina usually fully developed and usually very tapered and pointed; epiphallus anchor-shaped, dorsolateral appendices with small nodules on disc .... Atractomorphini Bolivar, 1905

I. Tribe Chrotogonini I. Bolivar, 1904

KEY TO GENERA OF THE TRIBE CHROTOGONINI I. BOLIVAR, 1904

1. Body strongly depressed; dorsum of pronotum strongly tuberculate; middle femur short, much shorter than head and pronotum together; hind femur with lower basal lobe longer than upper lobe; hind tibial spurs shorter than basal tarsal segment; arolium large; valve of cingulum narrow ....*Chrotogonus* Serville, 1838

— Body slightly depressed; dorsum of pronotum never strongly tuberculate; middle femur thin and strongly elongated, as long as or longer than head and pronotum together; hind femur with lower basal lobe shorter than upper lobe; hind tibial spurs longer than basal tarsal segment; arolium large; valve of cingulum broad.............*Tenuitarsus* Bolivar, 1904

a. Genus *Chrotogonus* Serville, 1838

KEY TO SPECIES OF *CHROTOGONUS* SERVILLE, 1838

1. Tegmina slightly reaching near apex of hind knee; wings hyaline, slightly shorter than tegmina 2

— Tegmina surpassing the apex of hind knee; wings dark, much shorter than the length of tegmina; aedeagus broad with sclerites and valves blunt apically .... *Chrotogonus oxypterus* (Blanchard, 1836)

2. Body yellowish-brown with metazoan of pronotum and mid hind femur outer and upper surface white; aedeagus narrow with sclerites and valves blunt apically .... *Chrotogonus armatus* Steinmann, 1965

— Body uniformly yellowish-brown without white marking; aedeagus very narrow with sclerites and valves pointed apically .... *Chrotogonus trachypterus* (Blanchard, 1836)

1. *Chrotogonus oxypterus* (Blanchard, 1836)

Epiphallus (Fig. 2A): Bridge-shaped, bridge moderately slender, slightly wider and long; anterior projection prominent with angular tip; lateral plates separated medially, lophi with curved apices, apex acute; lateral appendices rod-shaped and hooked at the end, apex pointed and reaching the tip of lophi.

Phallus (Figs 3A, 4A): Deep and concave basal emargination with shallow basal thickening, suprazygomal plate narrow, dorsal cleft broad and rounded at the base, valve of cingulum short and rame narrow, ventral process long and narrow, apodemal plates slightly wider; aedeagus broad with sclerites and valves blunt apically in dorsal view and regularly curved upward in lateral view.

2. *Chrotogonus armatus* Steinmann, 1965

Epiphallus (Fig. 2B): Bridge-shaped, bridge more slender, slightly narrow and elongated; anterior projection less prominent; lateral plates separated medially, lophi with curved apices, apex acute; lateral appendices rod-shaped and hooked at the end, apex expanded and crossing the tip of lophi.

Phallus (Figs 3B, 4B): Deep and concave basal emargination with light basal thickening, suprazygomal plate wide, dorsal cleft wider and angular at the base, valve of cingulum much longer, ventral process comparatively smaller and broad, rame narrow, narrow apodemal plates; aedeagus narrow with sclerites and valves blunt apically in dorsal view and regularly curved upward in lateral view.

3. *Chrotogonus trachypterus trachypterus* (Blanchard, 1836)

Epiphallus (Fig. 2C): Bridge-shaped, bridge more slender, wider and long; anterior projection prominent with obtusely conical apex; lateral plates separated medially, lophi with curved apices, apex acute; lateral appendices rod-shaped and hooked at the end, apex slightly expanded and crossing the tip of lophi.

Phallus (Figs 3C, 4C): Deep and concaved basal emargination with broad basal thickening, suprazygomal plate narrow, dorsal cleft small and rounded at the base, valve of cingulum long and narrow apically, ventral process small and narrow, rame comparatively wider, very narrow apodemal plates; aedeagus very narrow with sclerites and valves pointed apically in dorsal view and slightly curved upward in lateral view.

b. Genus *Tenuitarsus* Bolivar, 1904

4. *Tenuitarsus orientalis* Kevan, 1959

Epiphallus (Fig. 2D): Bridge-shaped, bridge small and slightly wider than long; anterior projection less prominent with conical apex; lateral plates separated medially, lophi with curved apices, apex obtusely conical; lateral appendices rod-shaped and pointed at the apex and crossing the tip of lophi.

Phallus (Figs 3D, 4D): Deep and concave basal emargination with shallow basal thickening, suprazygomal plate broad, dorsal cleft broad and flat at the base, valve of cingulum long and broad, rounded apically, ventral process small and narrow, rame narrow, apodemal plates slightly wider; aedeagus broad and short with sclerites and valves pointed apically in dorsal view and curved upward in lateral view.

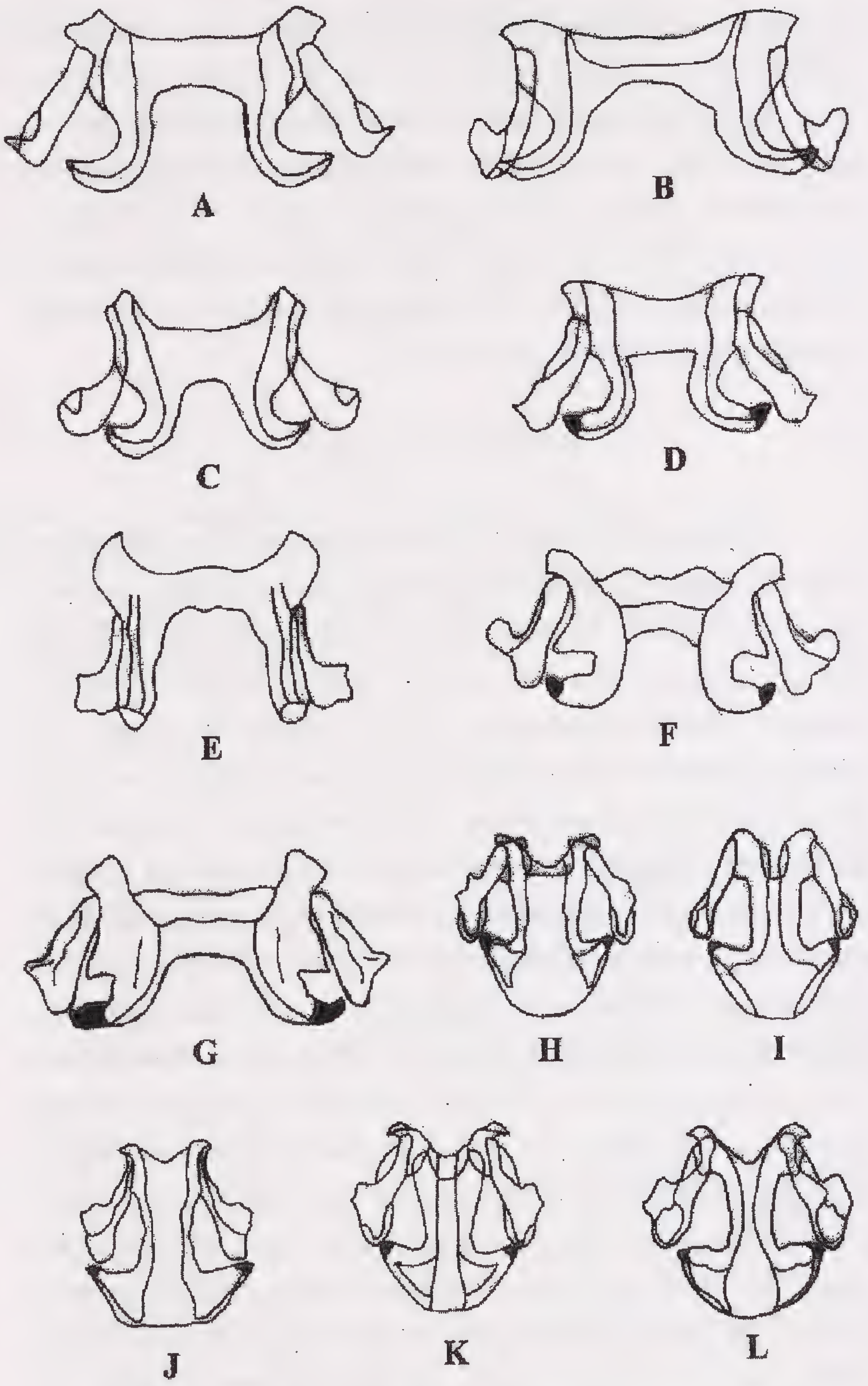

Fig. 2: Epiphallus: A. *Chrotogonus oxypterus* Blanchard, 1836, B. *Chrotogonus armatus* Steinmann, 1965, C. *Chrotogonus trachypterus trachypterus* Blanchard, 1836, D. *Tenuitarsus orientalis* Kevan, 1959, E. *Poekilocerus pictus* (Fabricius, 1775), F. *Pyrgomorpha conica* (Olivier, 1791), G. *Zarytes squalinus brachycerus* (Kirby, 1914), H. *Atractomorpha angusta* Karsch, 1888, I. *Atractomorpha burri* Bolivar, 1905, J. *Atractomorpha crenulata* (Fabricius, 1793), K. *Atractomorpha psittacina psittacina* (Haan, 1842), L. *Atractomorpha sinensis sinensis* Bolivar, 1905

II. Tribe Poekilocerini Burmeister, 1840

c. Genus *Poekilocerus* Serville, 1831

5. *Poekilocerus pictus* (Fabricius, 1775)

Epiphallus (Fig. 2E): Bridge-shaped, bridge long and

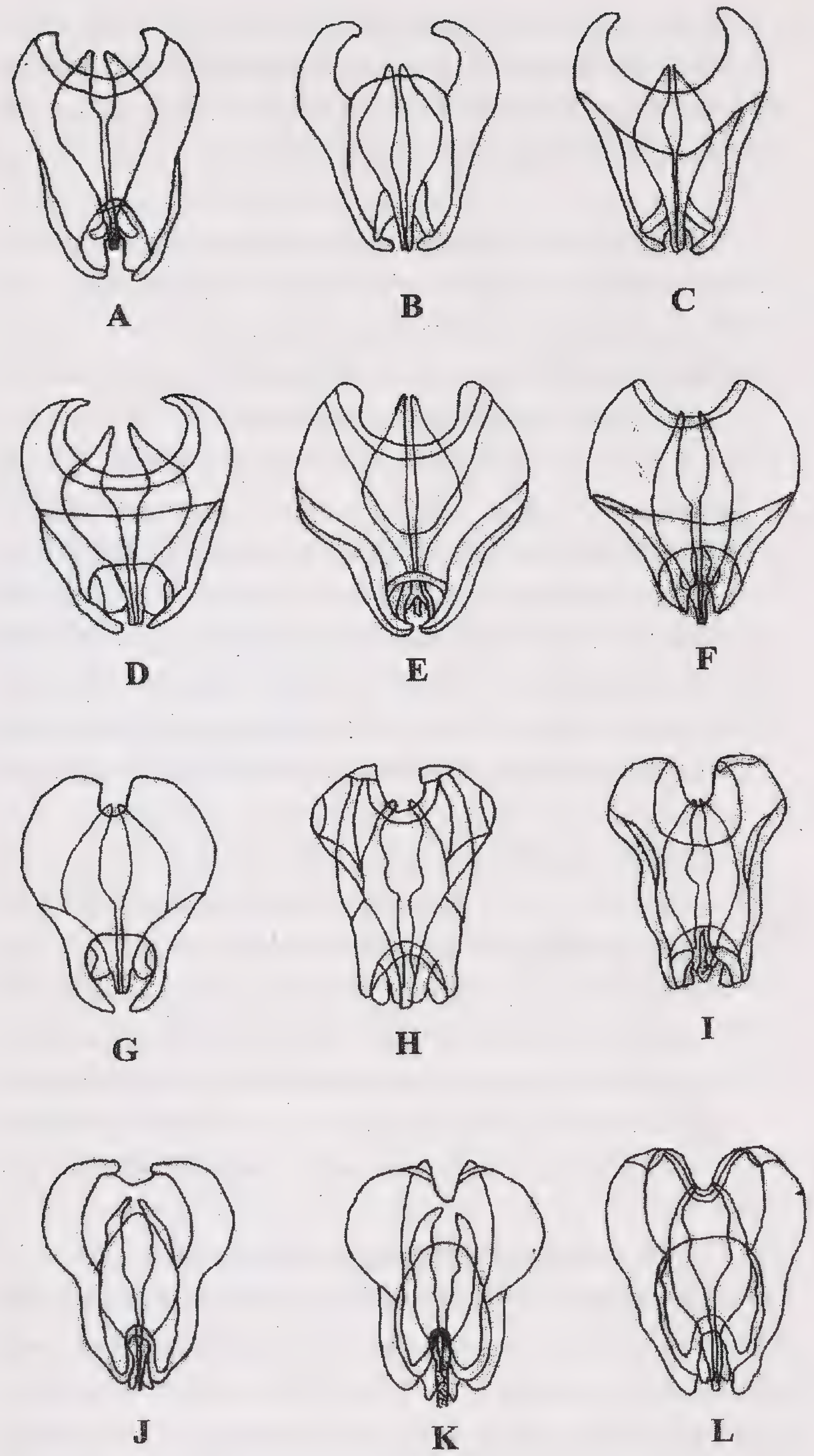

Fig. 3: Dorsal view of Phallus: A. *Chrotogonus oxypterus* Blanchard, 1836, B. *Chrotogonus armatus* Steinmann, 1965, C. *Chrotogonus trachypterus trachypterus* Blanchard, 1836, D. *Tenuitarsus orientalis* Kevan, 1959, E. *Poekilocerus pictus* (Fabricius, 1775), F. *Pyrgomorpha conica* (Olivier, 1791), G. *Zarytes squalinus brachycerus* (Kirby, 1914), H. *Atractomorpha angusta* Karsch, 1888, I. *Atractomorpha burri* Bolivar, 1905, J. *Atractomorpha crenulata* (Fabricius, 1793), K. *Atractomorpha psittacina psittacina* (Haan, 1842), L. *Atractomorpha sinensis sinensis* Bolivar, 1905

narrow, has a small median process on the posterior margin; anterior projection prominent with conical apex; lateral plates separated medially, lophi triangular; lateral appendices closely applied to lateral plates, rod-shaped and expanded at the apex and just reaching the tip of lophi.

Phallus (Figs 3E, 4E): Pear-shaped, basal emargination distinct and fairly deep with collar-like basal thickening, suprazygomal plate large, broadly tongue-like, dorsal cleft broad and rounded at the base, valve of cingulum distinct, flat, narrow, ventral process triangular, rame wider, apodemal plates wider and curved apically; aedeagus broad and short with sclerites and valves pointed apically in dorsal view and slightly curved upward in lateral view.

III. **Tribe Pyrgomorphini Brunner, 1882**

Key to Genera of Pyrgomorphini Brunner, 1882

1. Head abruptly convex dorsally in lateral view; frons strongly concave; pronotum with lateral carinae irregular; lateral pronotal lobes with posterior angles rounded or truncate; tegmina completely developed or moderately shortened, reaching the middle of the abdomen or still longer, sometimes contiguous on the medio-dorsal line; wings not shorter or hardly shorter than the tegmina; aedeagus straight, narrow, short and stout with sclerites, and valves blunt apically in dorsal view and slightly curved upward in lateral view .....
....*Pyrgomorpha* Serville, 1838

— Head less abruptly convex dorsally in lateral view; frons less strongly concave; pronotum with lateral carinae well-developed and straight, lateral pronotal lobes with posterior angles rectangular; aedeagus with broad sclerites and valves short and upwardly curved in lateral view ....
....*Zarytes* Bolivar, 1904

d. Genus *Pyrgomorpha* Serville, 1838

6. *Pyrgomorpha conica* (Olivier, 1791)

Epiphallus (Fig. 2F): Bridge-shaped, bridge narrow and posteriorly concave; anterior projection not prominent and straight; lateral plates separated medially, broader at basal half, lophi hooked with pointed apex; lateral appendices rod-shaped, much expanded at the apex, and just reaching the tip of lophi.

Phallus (Figs 3F, 4F): Basal emargination shallow and concave in dorsal view with moderate basal thickening, suprazygomal plate broad, dorsal cleft narrow and rounded at the base, valve of cingulum short and distinct, ventral process small and narrow, rame wider and pointed at apex, apodemal plates wider; aedeagus straight, narrow, short and stout with sclerites and valves blunt apically in dorsal view and slightly curved upward in lateral view.

e. Genus *Zarytes* Bolivar, 1904

7. *Zarytes squalinus brachycerus* (Kirby, 1914)

Epiphallus (Fig. 2G): Bridge-shaped, bridge broader; anterior projection not prominent; lateral plates separated medially, broader at basal half, lophi hooked with pointed apices; lateral appendices rod-shaped, slightly expanded at the apex, and just reaching the tip of lophi.

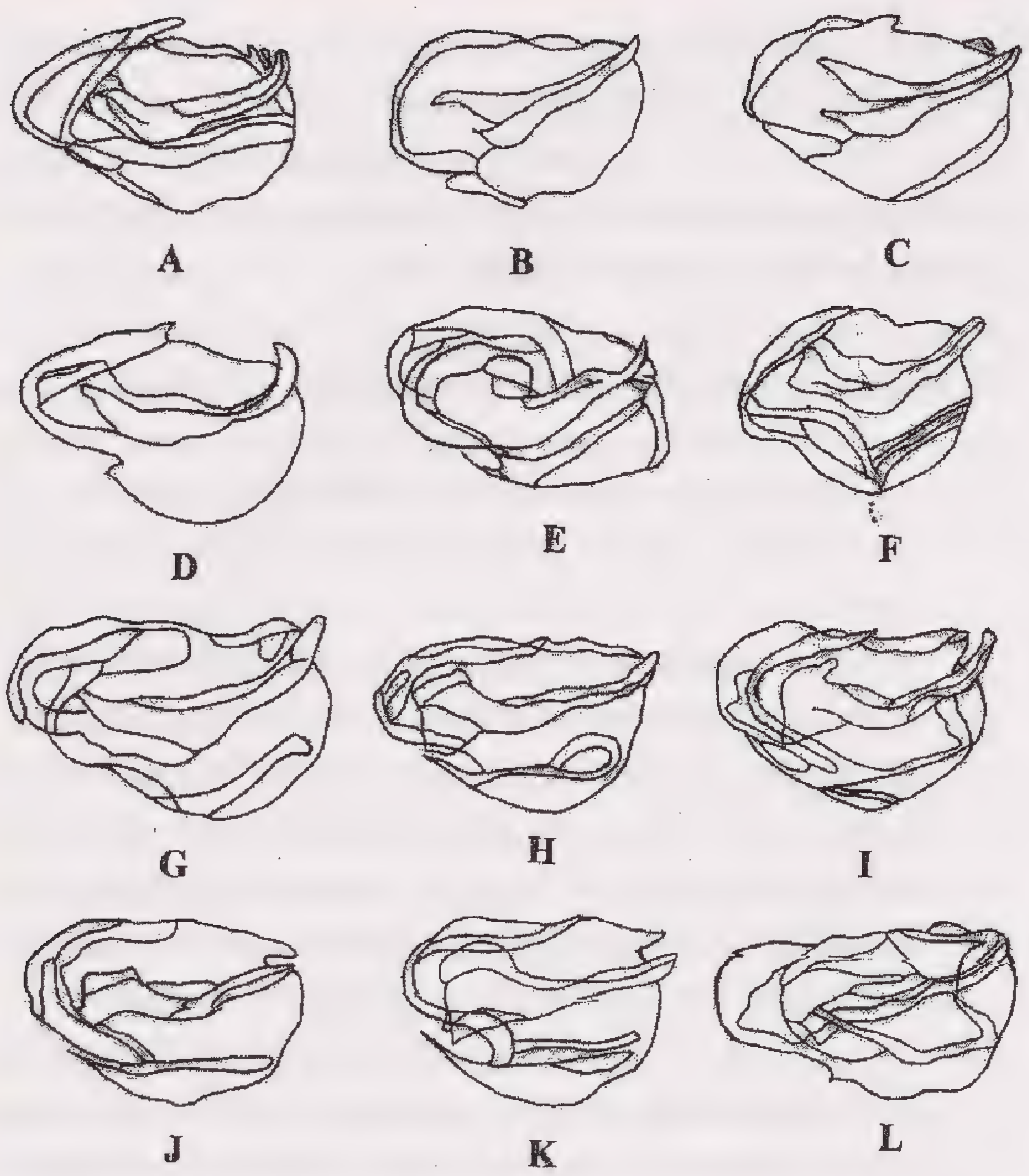

Fig. 4: Lateral view of Phallus: A. *Chrotogonus oxypterus* Blanchard, 1836, B. *Chrotogonus armatus* Steinmann, 1965, C. *Chrotogonus trachypterus trachypterus* Blanchard, 1836, D. *Tenuitarsus orientalis* Kevan, 1959, E. *Poekilocerus pictus* (Fabricius, 1775), F. *Pyrgomorpha conica* (Olivier, 1791), G. *Zarytes squalinus brachycerus* (Kirby, 1914), H. *Atractomorpha angusta* Karsch, 1888, I. *Atractomorpha burri* Bolivar, 1905, J. *Atractomorpha crenulata* (Fabricius, 1793), K. *Atractomorpha psittacina psittacina* (Haan, 1842), L. *Atractomorpha sinensis sinensis* Bolivar, 1905

Phallus (Figs 3G, 4G): Basal emargination narrow and concave in dorsal view with shallow basal thickening, suprazygomal plate broad, dorsal cleft narrow, elongated and obtusely conical at the base, valve of cingulum short and distinct, ventral process small and narrow, rame narrow, apodemal plates wider; aedeagus with broad sclerites and valves short and upwardly curved in lateral view.

IV. Tribe Atractomorphini Bolivar, 1905

f. Genus *Atractomorpha* Saussure, 1862

KEY TO SPECIES OF *ATRACTOMORPHA* SAUSSURE, 1862

1. Eyes elongate oval 2

— Eye roundish oval or ovoid 3

2. Build short and moderately stout; head and pronotum relatively short; fastigium of vertex short; lateral pronotal lobe fairly deep, without a membranous area in metazoan; aedeagal valve long and slender, curved upwardly in lateral view .... *Atractomorpha burri* Bolivar, 1905

— Build very slender; head and pronotum relatively long; fastigium of vertex narrower and longer; lateral pronotal lobe shallower, sometimes with a small membranous area in the metazoan; aedeagal valves longer and more strongly curved .... *Atractomorpha psittacina* (Haan, 1842)

3. Generally small; membranous area in metazoan of lateral pronotal lobe usually very distinct in female and well-indicated in male; hind wings normally tyrian pink to light mallow purple or pale magenta at base, but quite often heavily infumated; aedeagal valve small and short .... *Atractomorpha crenulata* (Fabricius, 1793)

— Size range variable; membranous area in metazoan of lateral pronotal lobe variably developed; hind wings pinkish to rose red or rose at base, less frequently infumated 4

4. Size as a rule a little smaller, body length often less than 20 mm in male or 30 mm in female; fastigium of vertex generally narrower apically and less flat dorsally; hind wings rose red, frequently infumated, at least basally; aedeagal sclerites and aedeagal valves slightly shorter and less gradually tapered .... *Atractomorpha angusta* Karsch, 1888

— Size generally a little larger, body length usually more than 20 mm in male or 30 mm in female; fastigium of vertex usually broad and generally very flat dorsally; hind wings rose red or rose, not frequently infumated; aedeagal sclerites and aedeagal valves slightly longer and more gradually tapered .... *Atractomorpha sinensis* Bolivar, 1905

8. *Atractomorpha burri* Bolivar, 1905

Epiphallus (Fig. 2H): Anchor-shaped, bridge small, anterior projections not prominent; lateral plates broad and fused medially, broader at the base, middle piece much wider, lophi hooked with conical apex; lateral appendices rod-shaped, slightly expanded at apex, reaching up to the apex of lophi.

Phallus (Figs 3H, 4H): Capsule-shaped, basal emargination concaved in dorsal view with shallow basal thickening, supra zygomal plate slightly narrow, dorsal cleft broad and rounded at the base, valve of cingulum longer, ventral process long and narrow, rame broad, apodemal plates narrow; aedeagal valve long and slender and curved upwardly in lateral view.

9. *Atractomorpha psittacina psittacina* (Haan, 1842)

Epiphallus (Fig. 2I): Anchor-shaped, bridge very narrow; anterior projections not prominent, with rounded apex; lateral plates fused medially, middle piece narrow, lophi hooked with pointed apex; lateral appendices rod-shaped, expanded at apex, slightly far from the apex of lophi.

Phallus (Figs 3I, 4I): Capsule-shaped, basal emargination concave in dorsal view with shallow basal thickening, suprazygomal plate slightly narrow, dorsal cleft broad and dome-shaped at base, valve of cingulum moderate, ventral process long and narrow, rame narrow, apodemal plates narrow; aedeagal valves long and more strongly curved.

10. *Atractomorpha crenulata* (Fabricius, 1793)

Epiphallus (Fig. 2J): Anchor-shaped, bridge broadt, anterior projections prominent with pointed apex, lateral plates fused medially, middle piece with subparallel margins, lophi hooked with pointed apex; lateral appendices rod-shaped, slightly expanded at apex, slightly far from the apex of lophi.

Phallus (Figs 3J, 4J): Capsule-shaped, basal emargination concave in dorsal view with shallow basal thickening, suprazygomal plate narrow, dorsal cleft broad and rounded at the base, valve of cingulum long, ventral process long and narrow, rame narrow and rounded at the end, apodemal plates broad; aedeagal valve small and short.

11. *Atractomorpha angusta* Karsch, 1888

Epiphallus (Fig. 2K): Anchor-shaped, bridge narrow; anterior projections prominent with pointed apex; lateral plates fused medially, broader at base, middle piece slightly wider, lophi hooked with obtusely conical apex; lateral appendices rod-shaped, expanded at apex, usually reaching the apex of lophi.

Phallus (Figs 3K, 4K): Capsule-shaped, basal emargination concave in dorsal view with shallow basal thickening, suprazygomal plate slightly wider, dorsal cleft broad and rounded at the base, valve of cingulum short, ventral process long and narrow, rame narrow and rounded at the end, apodemal plates broad, aedeagal sclerites and aedeagal valves slightly short and less gradually tapered.

12. *Atractomorpha sinensis sinensis* Bolivar, 1905

Epiphallus (Fig. 2L): Anchor-shaped, bridge wider, anterior projections prominent with hook like apex; lateral plates fused medially, broader at base, middle piece slightly narrow, lophi hooked with obtusely conical apex; lateral appendices rod-shaped, much expanded at apex, slightly far from the apex of lophi.

Phallus (Figs 3L, 4L): Capsule-shaped, basal emargination concave in dorsal view with shallow basal thickening, suprazygomal plate form a triangular plate-like structure, dorsal cleft broad and rounded at the base, valve of cingulum short, ventral process long and narrow, rame narrow and rounded at the end, apodemal plates less extensive, aedeagal sclerites and aedeagal valves slightly long and more gradually tapered.

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THE TRADE, TRAPPING, AND UTILIZATION OF LORISES IN INDIA

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Slow Loris *Nycticebus bengalensis* and Slender Loris *Loris lyddekerianus* are much favoured species in the illegal live mammal trade. Lorises are small sized furry primates, having large round eyes. They are easy to keep due to their omnivorous diet and a solitary lifestyle. Lorises rank high on the cute-and-cuddly scale and are much sought after as pets worldwide. This paper discusses the more or less covert trade, trapping and organised wildlife trafficking, and utilisation of lorises in India.

Key words: Slow Loris, *Nycticebus bengalensis*, Slender Loris, *Loris lyddekerianus*, live mammal trade, primate, pet trade

INTRODUCTION

Indian primates are totally protected under the Wildlife (Protection) Act, 1972 (WPA), but most are still illegally exploited in one way or another. Primates are the most popular group in the live mammal trade, and illegally traded, both domestically and internationally, for the biomedical and pharmaceutical markets, the entertainment and pet industries. Primates are also much sought after by zoological parks and private animal collections (Ahmed 2001; Malik *et al.* 1997; Srivastava 1999). Until 1978, India was a leading exporter of monkeys to various countries (Ahmed 2001). Primates are also hunted by several forest tribes and their meat is relished in certain regions. The body parts are used in traditional medicine, sold as curios, or the skin is used as casing. On rare occasions, primate parts are also used in black magic and sorcery (Bhel 1998).

Among the Indian primates, lorises are much favoured in the live mammal trade, and are often sold as pets in Indian and international markets (Ahmed 2012; Menon and Kumar 1998). I have been monitoring bird markets across India since 1992, and during the more than 300 field surveys across all the Indian states, I have encountered the sale of lorises in some animal markets, especially at village *haat*s in the distribution areas of the species. This manuscript discusses the trade, trapping methods, and utilisation of lorises in India.

Lorises of India, their distribution and legal status

India is home to two species of nocturnal prosimians (lorises) belonging to the Suborder Strepsirrhini, namely Slow Loris *Nycticebus bengalensis* (Boddaert) and Slender Loris *Loris lyddekerianus* (Linnaeus). The Slow Loris can be differentiated from the Slender Loris by its distinctive brown stripe, marking the middle line of its back, and is comparatively larger than the Slender Loris. The Slow Loris is found in dense, moist deciduous, semi-evergreen, and evergreen forests throughout north-east India, more commonly south of the River Brahmaputra, while the Slender Loris is distributed throughout southern India, south of the Rivers Tapti and Godavari up to 800 m above msl (Menon 2003).

The Slow Loris is listed as Vulnerable in the IUCN Red List of Threatened species due to loss of habitat and severe hunting pressures, and in Appendix I of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). The Slender Loris is listed by IUCN as Near Threatened, and is listed in Appendix II of CITES.

Trade and utilisation of lorises

Lorises are furry, have large, round eyes, omnivorous diet, a solitary lifestyle, and unique behaviour – they can hang upside down. For these and other reasons, they rank high on the cute-and-cuddly scale, and have been long in demand as pets worldwide. Trade is considered a major threat to most loris species, especially in Southeast Asian countries. The Slow Loris remains a common sight in wildlife markets of Indonesia, Thailand, and Singapore (TRAFFIC n.d.). In India, main reasons for trade in lorises are the small size, silent behaviour (they do not 'cry' in captivity), being easy to keep due to their omnivorous diet, their easy availability, and less difficulty faced by animal traders in transporting them compared to other primates. Their exotic and 'cute look' make them a favourite trade commodity, yielding high profits to the organised wildlife traffickers who target farm owners and animal enthusiasts interested in rare, exotic pets. In India, lorises have been known to be captured for years. Prater (2005) states "As with lemurs in all countries, a wealth of superstitious beliefs centre around these animals. The eyes are said to be a potent love charm, and are also used as a cure for certain eye diseases. Hence, the capture and sale of these animals, which are cruelly hawked about to the blinding glare of sunlight, to which by nature they are so ill-accustomed."

Lorises were exported worldwide from India along with birds until the blanket ban in 1990–1991. Prior to the ban, the Slender Loris, locally called *Lajwanti* in Hindi by animal dealers, was brought to north India from Bengaluru (earlier Bangalore) animal dealers. The Slow Loris, locally called *Sharmili billi* in Hindi by animal dealers in north India, was sourced from Patna for exporters in Uttar Pradesh. Until a decade ago, the Slow Loris was regularly sold at the famous Sonepur fair in Bihar, while the Slender Loris was a common mammal for sale at the Shivaji bird market in Bengaluru (Ahmed 2001). I recorded 28 Slow Loris during eighteen surveys between 1994 and 2011 in 11 sites in four states, and not less than 22 Slender Loris in six sites in four southern Indian states between 1994 and 2002. These numbers may not look significant, but these records were not from a specific survey for these species, but incidental to one on documenting the bird trade.

In India, lorises are utilised in various ways. The Slow Loris is poached for food in Meghalaya (Radhakrishna *et al.* 2010) and Mizoram (Joydeep Bose *pers. comm.* 2012). They are hunted in north-east India by the Angamis, Apatanis, Nishis, and Mizos for bushmeat (Hilaluddin *et al.* 2005), and also kept commonly as pets (Nandini *et al.* 2009). In southern India, roadside astrologers use Slender Loris for picking up fortune cards (Ahmed 2001). Tribals in Kerala claim that keeping a Slender Loris can ward off evil spirits. Though lorises are used in traditional medicine, they are more common in the pet trade. Lorises are also sold to zoos and private collections, and were formerly used as exhibits in travelling zoos, a practice that is now almost over due to the ban on travelling zoos.

The pet trade in lorises in India is done in a covert manner, and it is not openly offered or displayed as in several Asian countries. There is a growing demand for exotic pets in India, and exotic birds are the major attraction in most private collections, since there is no ban on the domestic trade and possession of exotic birds. Many large collections also have a number of small exotic mammals, such as Sugar Gliders *Petaurus breviceps*, marmosets (Callitrichidae), and bush babies (Galagidae), each of which may cost more than Rs. 100,000 for a pair. On many occasions, new or ignorant buyers are conned into buying Slow or Slender Loris and Giant Squirrel (*Ratufa indica*) as exotic pets at exorbitant prices. Unlike most Southeast Asian countries where the Slow Loris has its teeth cut or extracted for the pet trade to avoid being bitten, this is not practiced in India, and the animals are invariably kept in cages. However, I was told that one can get tame lorises with their teeth removed. The animal traders also said that the lorises are not sold as 'toy pets' but to serious animal collectors. Due to the strong odour emitted, most of the buyers who are rich and finicky about keeping such animals in their houses return them. To avoid the problem due to foul odour of these species, traders offer them instead as outdoor pets for which they can command high prices.

There are tribes or village-level trappers who make collection trips almost thrice a week in forests, who on chance encounters with lorises often capture and covertly sell them at the village level. Even if the animal dies (from starvation mostly), the body is dried and parts sold for traditional medicine. There is some international demand for lorises, mainly in Thailand, and the lorises are transported to Bangkok (via Dhaka) or to Karachi by animal dealers. Earlier, Kathmandu was the main transit point, from where the Slow Loris were smuggled to Thailand by subdealers and middlemen, but due to increased vigilance, the centre is now Dhaka. In India, the main collection centres are Patna and Burdwan from where the lorises are routed to these countries. Recent surveys in north-east India suggest that these animals may also be routed to Myanmar via Moreh (Manipur).

Loris Trappers and Traders

The organised countrywide trade is either carried by Mirshikar traders from Patna or by certain tribals from southern India, such as the Narikorava and Hakki pikki. Mirshikars do not catch the Slow Loris on their own, but obtain them from subdealers from the North-East, who buy them from village-level trappers in Assam, Meghalaya, and Nagaland, and bring them to the Mirshikar traders based in Patna and Siliguri (collection centres). The tribals of north-east India such as Garo, Nishi, and Karbi occasionally sell Slow Loris in the village markets. The Mirshikar traders of Patna or Burdwan send the Slow Loris to dealers and pet keepers throughout India.

The Narikorava and Hakki pikki mostly live a nomadic life and seasonally hunt wildlife at forest peripheries. Pakshirajpuram (a tiny settlement of professional animal trappers) near Hosur on the Nagarhole road used to be one of the primary collection centres from where Slender Lorises were sent to the Bengaluru and Chennai markets on demand. Historically, the animal markets at Benson town in Bengaluru and Moore Market in Chennai openly displayed and sold these animals, a practice that has completely gone underground. Now a few animals are delivered only through known customers on request.

The organised trade of Slender Loris in Kerala takes place through middlemen in Malayttur and Angamali, who may send the animals to the Coimbatore, Alvaye, and Madurai markets on specific demand. The collection is done by the Kani tribe or city-based organised trappers. Some Slender Lorises are collected near the Wayanad forest and the stock is send to Thrissur and Kozhikode dealers. Slender Lorises are also collected by travelling Narikoravas of Villipuram in Tamil Nadu, who at times sell their catch in Chennai, and to animal traders from southern India.

The Pardhi tribe of Central India, who hunt and deal with many wildlife products, also sell the Slender Loris's body parts for their supposed medicinal value in Indian cities.

Collection Methods of Lorises

Lorises are slow and silent. Once disturbed, they immediately freeze, and are docile. Their nocturnal habits, and at times choice of sleeping sites on exposed branches, make them easy targets for trappers. In the case of the Slender Loris, trappers use powerful torches to immobilise them when they come to feed on lower branches. Using poles with curved knives, used for bringing down leafy branches for livestock, the animals are caught by cutting off the branches. If the branches are not reachable, a rope (with a stone) is used to pull down the branch.

In north-east India, the Slow Loris is reported to be collected in a similar fashion by bringing the branch down or by felling the tree. However, my interviews with grassroots-level trappers suggested that the majority of Slow Loris are collected from tree cavities or crevices, when the trappers search for chicks of mynas, parakeets, and hornbills. This appears to be true as I recorded the loris mainly during my surveys for trade in hornbills and mynas in north-east India.

Major Trade Routes and Trade Centres in India

Some collection centres for organised loris trade were recorded during my surveys. Live Slow Lorises collected from the north-eastern states are transported via Siliguri either to Mirshikar-toli in Patna or the animal traders in Burdwan, from where they are distributed to various domestic and international animal markets, depending on the demand from city-based retailers. The lorises are transported in small iron cages measuring less than one cubic foot. They are mainly fed munia birds and sometimes infant food mixed with egg, banana, and sometimes rice. The collection at the primary level is by the Karbi people, who bring their catch for sale at the weekly *haat* (village market) such as Balipathar and Silonijan on the Assam-Nagaland highways, while the actual collection takes place from peripheral forest areas. Some animals are taken by subdealers from Dimapur and Kohima for local sale. Stocks from Meghalaya reach Bijoynagar (or Boko) from Adokgre and Dudpdara (east Garo Hills), which is routed to Nepal via Jogbani or to Patna via Katihar.

Comparing my surveys in the early 1990s with the ones in 2007 and 2011, it appears that most Slow Loris are now sold locally near collection centres, rather than bulk animals being transported to the organised markets due to fear of seizures. The lorises are now transported hidden with domestic animals, especially pigeons. To calm and make the animal drowsy, crushed onions are reportedly kept in boxes, a practice which needs verification.

Prices of Lorises

According to information based on a recent seizure in Karnataka, the price quoted for each Slender Loris is Rs. 35,000. Based on my surveys, I found the price of a Slow Loris at village-level markets in Assam was between Rs. 300–600. In the Nagaland food markets, the prices ranged from Rs. 500–1,000, and in the villages it was about Rs. 200–300 at the collection level. In Patna, the Slow Loris can easily sell between Rs. 3,000–8,000 for a pair. In southern India, near Bengaluru, a Pakshirajpuram dealer quoted a price of Rs. 1,500 for a pair of Slender Loris in 1997, and in Bengaluru and Kozhikode markets, a pair at retail level could cost up to Rs. 20,000. In tribal areas, the same can be obtained for Rs. 200–300.

Conservation

The recent seizures of lorises from India are indicators of their ongoing trade in India. In June 2012, a Slow Loris kept as a pet in South Garo Hills, Shillong, was rescued (Anon. 2012). Two Slender Loris were seized in Goa on the way to Karnataka in September 2011 (Wildlife Crime in India n.d.). In March 2011, two Slow Loris were rescued in Karbi Anglong from locals (Wildlife Trust of India n.d.). In July 1996, three Slender Loris skins were seized from Narikorava tribals in Karnataka (Anon. 1996).

Hence, despite Indian lorises being included in Schedule I of the WPA and in Appendices I and II of CITES, both species are threatened by illegal trade and need greater law enforcement at the grassroots level. Studies to determine the impact and extent of such illegal activities affecting local populations, and stringent enforcement of laws and punishment for poachers need to be undertaken. There is also a need for education and awareness programmes to highlight the plight of lorises in the species distribution areas.

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OBITUARY

T.J. Roberts

(1924 – 2013)

Dr. Thomas Jones Roberts, popularly known as Tom Roberts, was one of the finest amateur ornithologists and naturalists of the Indian subcontinent. Although he worked mainly in Pakistan for almost 30 years, his knowledge of the Subcontinent's fauna and flora was phenomenal, as reflected in his monumental books. Tom Roberts wrote 40 research papers, numerous popular articles on nature, and seven books. His two-volume THE BIRDS OF PAKISTAN, based on his extensive travels in the country for 28 years, covering all 660 recorded species, came out in 1991–92, and became an instant success. I had the privilege to have a signed copy. I first met Tom and his lovely wife Frances during the BNHS Centenary seminar in 1983. Along with Dr. Sálim Ali, Mr. Humayun Abdulali, and Dr. B. Biswas, they made a formidable group – the stalwarts of the ornithology of South Asia.

Tom Roberts was an accomplished artist – this is proved from the wonderful illustrations in his books. During the writing of his book, THE BIRDS OF PAKISTAN, he came twice to India in the 1980s to consult the BNHS bird collection. Along with his wife, he would come to BNHS at 08:30 a.m. sharp and work till late evening, meticulously going from specimen to specimen, making notes of plumage, beak, tarsus, and illustrating when necessary. I was eager to help him in getting specimens, but he politely refused my help as he wanted to concentrate fully on the work that he had planned in his short trip. Job done, we went to dinner one evening when he told me about the birdlife of our neighbouring country. He also promised to send me a signed copy of his book, which he did when it came out in 1991–92.

Tom Roberts was a complete naturalist. In 1977, he wrote and illustrated THE MAMMALS OF PAKISTAN. For his second revised edition published by the Oxford University Press in 1999, he also used some mammal images sent by me from India. His other books are HANDBOOK OF VERTEBRATE PEST CONTROL IN PAKISTAN (1981), THE BUTTERFLIES OF PAKISTAN (2001), FIELD GUIDE TO THE SMALL MAMMALS OF PAKISTAN (2005), and FIELD GUIDE TO THE LARGE AND MEDIUM-SIZED MAMMALS OF PAKISTAN (2005).

Tom Roberts was born on September 2, 1924 in North Wales, UK. His father had a business in Pakistan, which he visited in 1946 and fell in love with the Subcontinent. He went to Canada as a young man to study Agricultural Economics, then a new subject, in the University of British Columbia. He met Frances and soon married her. In 1952, he returned to Pakistan to join his father's company Roberts Cotton Associates Ltd. In 1966, he took over as Managing Director of the company and retired in 1984, shifting to UK after some years.

For his pioneering work in Pakistan, in 1994 he was awarded *Sitara-e-Imtiaz* by the Government of Pakistan. One year before that, Queens' College, Cambridge, awarded him a doctorate. Later, he received many awards for his work on birds, butterflies, insects, and mammals. Tom was also a member of many societies and committees. He was the founding father of WWF-Pakistan and a strong pillar of International Council for Bird Preservation (renamed BirdLife International in 1994). He was also a founding member of the Oriental Bird Club, UK. Dr. Roberts served as a member of the board of governors of World Wide Fund for Nature-Pakistan from 1985 to 1991 and the organisation's scientific committee. Thrice he was awarded the WWF-International Award for Conservation Merit.

Even at an advanced age, in his 80s, Roberts was active in studying the local wildlife of his beloved Anglesey, North Wales, where he had settled with Frances.

With the passing away of Dr. Thomas Jones Roberts, the Indian subcontinent has lost one of the stalwarts of oriental ornithology. His books will educate and delight us for many more years. I hope the conservation message given in his writings will stir our neighbour, not known for its conservation record. If a societal change takes place there, it will be the finest tribute to the great man who spent the better part of his life documenting the fauna and flora of the country.

■ ASAD R. RAHMANI

Zafar Futehally

(1920 – 2013)

Zafar Futehally was elected to the Executive Committee of the Bombay Natural History Society in 1962, and soon thereafter took up the post of Vice President, and perhaps held this post longer than anyone else in the Society's history.

His phenomenal capacity for work is well illustrated by the fact that while steering the affairs of the Society, he also co-edited the Society's *Journal* for 10 years from April 1963.

At a time when 'conservation' was a new buzzword in India, Zafar started WWF-India, and was its Founder Trustee and Vice President for over a decade. Zafar was also elected to the Executive Board of the IUCN in 1966. He served as a member of the National Committee for Environment Planning, and along with M. Krishnan, was appointed as a 'non official' member of the Steering Committee of Project Tiger when it was launched in 1973. He was also closely involved with the International Ornithological Congress.

Zafar started the *Newsletter for Birdwatchers* with the active encouragement of Dr. Sálim Ali in 1959, with the aim of promoting birdwatching and ornithology in India. The *Newsletter* went on to become an important forum for amateur and professional ornithologist to exchange notes and information, with Zafar as its Editor for 45 years!

Tall in stature and slight of build, Zafar was an excellent field person, though he came into his own as an effective 'committee man' with a penchant for striving to reach consensus, and eliminate conflicts.

This, along with his integrity and a deep commitment to the causes that he espoused for, not only stood the Society in good stead during a difficult period, but also contributed positively to the effective functioning of various national and international organisations that he was associated with.

He was a part of the effort that organised the 10th General Assembly and the 11th technical meeting of the IUCN that took place at New Delhi from 24th November to 1st December 1969 – a memorable Assembly in many ways, particularly for India, because it was the first instance when an IUCN Conference had been convened in Asia.

Zafar's report on this was published in the Society's *Journal* [Futehally, Zafar (1970): *JBNHS 67(1)*: 30–39].

Among the many resolutions passed during the 10th GA, the crisis enveloping the Tiger was finally recognised. "*The assembly was generally alarmed by the position of the tiger in India, and generally in other countries. It decided quite rightly that in view of the grave threat to the tiger populations in the countries where the animal occurs, due to direct and indirect methods of destruction ... the Governments of these countries (declare) a moratorium on killing of this animal until such time as censuses and ecological studies ... reveal the correct position as regards population trends*"

Zafar Futehally wrote in the Society's *Journal* "*Looking back on the Conference in the light of the experience of those held in other countries it must be acknowledged that the organization by and the hospitality of the Government of India left little to be desired. The presence of the Prime Minister, Dr. Karan Singh, the Minister of Tourism, and the Chairman of the Indian Board for Wildlife, and other senior Ministers and Members of the Planning Commission at several Sessions, both formal and informal, left the delegates with the quite justifiable impression that conservation will in future form an important item in the deliberations of the Government of India. It will, however, be left to institutions like the BNHS, the Wildlife Preservation Society of India, the World Wildlife Fund – Indian National Appeal and others, to see to it that the resolutions which are passed and which engaged the attention of the leading conservationists of the world are implemented as quickly as possible.*"

The *JBNHS*, Vol. 68, April 1971, proudly carried under 'Notes & News' the following:

"*Padma Shri - The President of the Republic of India has been pleased to award Padma Shri to Mr. Zafar Futehally, for his services to the Conservation of Indian Wildlife.*"

Zafar was presented with the Order of the Golden Ark by Prince Bernhard of the Netherlands in 1981, and made 'Member of Honour World Wildlife Fund' in 1994. In 1997, he was conferred with the Sálim Ali International Award for Nature Conservation in recognition of his efforts towards the conservation of Karnala and Borivali, Mumbai.

All these achievements and awards sat lightly on the shoulders of Zafar, with his only concern being to do his duty. After moving to Bangalore in 1973, he did "*his duty as a responsible citizen*" to work for saving the trees and revitalising the lakes. In recognition of his tireless efforts, the Government of Karnataka presented him the Rajyotsava Award in 1983. He believed that: "*Conservation would become the Religion of the Future because men can only survive on renewable natural resources – air, water, soil, flora and fauna.*"

Zafar Futehally's sterling contribution to the Bombay Natural History Society, and to the conservation of nature and natural resources has set high standards for us to emulate and live up to.

■ ASHISH AND SHANTHI CHANDOLA

REVIEWS

1. BUTTERFLIES OF THE GARO HILLS By Sanjay Sondhi, Krushnamegh Kunte, Gaurav Agavekar, Rohan Lovalekar, and Kedar Tokekar (2013). Published by Samrakshan Trust (New Delhi), Titli Trust (Dehradun), and Indian Foundation for Butterflies (Bengaluru). Size: 13.5 cm x 21cm. 200 pp. Price: Rs. 500/-. Paperback.

Today, the study of butterflies has become a passion for many. The availability of excellent digital cameras, improved transportation and the increasing availability of information has largely contributed to the spurt of interest in the subject. This is a boon for biodiversity documentation, as remote corners of our country have begun to be explored by both professionals and amateurs.

BUTTERFLIES OF THE GARO HILLS is a welcome addition to the growing literature on the subject, covering 320 species of the 350 species recorded so far from the Garo Hills. It is aimed specifically at an audience intending to visit the area. This book is the result of years of man-days of fieldwork by the authors, working together and separately; it has all the attributes of a good field guide, that is, a handy size, resilient binding, good paper, and clear illustrations.

The book opens with an encouraging Message and Foreword by two senior officials of the Meghalaya Forest Department – both hope that the book will help butterfly tourism, research, and conservation in the area. There is a small introduction to the Garo Hills, a section on conserving butterflies, and "How to use this book", explaining the sense behind the format and the meaning of terms used. This section contains a surprising assertion, in the 'Description' subsection: "Each species description starts with the butterfly wingspan, in millimetres measured as twice the forewing length from apex to wing base at the point of attachment to the thorax. The wingspans in the book are primarily from Evans (1932) and Talbot (1939–1947)." However, Evans (1932) had stated, "After the name of the butterfly there follows… the expanse of the butterfly in millimetres, obtained by measuring from the centre of the thorax (the pin) to the tip of the forewing and doubling the result..." Clearly, Evans' measurements include the thorax, which in some species such as the Rajahs (*Charaxes*), comprise a substantial proportion of the measurement. It is also true that the forewing length is nowadays often used in measuring butterflies. But anyone who has the slightest familiarity with butterflies or moths will know that 'twice the forewing length' is a meaningless measurement.

This method used for measurement is all the more astounding because the wingspan/forewing length is the only measurement used in studying butterflies and moths. In fact, a few months prior to the present publication, I had drawn the attention of some of the authors to this matter, in a previous book by one of the authors Krushnamegh Kunte BUTTERFLIES OF PENINSULAR INDIA (2000).

The next section is 'Identifying Butterflies'. It is correctly stated that in the case of some genera and species groups, one needs to hold the butterfly in the hand and examine normally obscured features like brands, which are situated between the fore and hind wings, in order to correctly place the species. The next sentence baffled me. It reads, "It is possible to catch butterflies using butterfly nets to observe these features, and release the butterfly unharmed, but the written permission of the State Forest Department is necessary before this can be attempted, especially within protected areas." This factoid is reinforced in the next paragraph with the assertion that "This requires collection of specimens which, too, requires written permission of the Chief Wildlife Warden of the State Forest Department." While the State Forest Departments are authorised to issue permission to collect specimens within protected areas and it is necessary to seek permission before using a net in such areas, written permission of the State Forest Department is certainly not required outside government forests and protected areas for resident Indian citizens. The only permission the State Forest Department can issue outside government forests and protected areas regarding butterflies is permission to collect species listed on Schedule 2 and 3 of the Wildlife (Protection} Act 1972. For Schedule 1, Central Government permission is required, but for species off the schedules, no permission is required. To take a net outside protected areas and government forest, catch butterflies, examine them, and release them unharmed is perfectly legal under current laws. Similarly, taking such specimens for scientific research within the country also does not require permission from anyone, unless the research is undertaken with the intent of commercialisation, in which case the State Biodiversity Board would need to receive prior intimation.

Proceeding to the systematic section, the families have been arranged alphabetically, as a result of which Riodinidae comes after Pieridae and far from Lycaenidae, which is not in consonance with their commonly accepted relatedness. The arrangement of species in the systematic section appears to follow no particular pattern, and differs from the arrangement in the section titled "Checklist of the Butterflies of the Garo Hills" (pp. 181–186). The authors also appear to be uncertain about the classification of Lycaenidae, as there is wrong placement of species in the subfamilies. The systematic section recognises the subfamily Polyommatinae (p. 34) with 36 species, but this subfamily is not listed in the Checklist (pp. 182–183), where these species are listed under the subfamily Lycaeninae. Clearly, the book very democratically incorporates divergent opinions, which unfortunately, leaves readers puzzled.

Of interest is the section called "Similar Species". This is meant to help separate butterflies that look similar. I tried using this section, but ran into a bit of trouble. For example, if I had a dark brown Skipper to be identified, I might look up Dark Velvet Bob *K. butleri* on page 7, where it would be suggested that I check Chocolate Demon *A. nigrita* on page 11. However, if I had turned to the Chocolate Demon first, I would not be referred back to the Dark Velvet Bob on page 6, but to Watson's Demon *S. swinhoei*, which, after due diligence, I discovered is not included in the book (it has not been recorded from the area so far).

Most species are represented by a single photograph, which is often adequate to recognise the species in the case of distinctive species. However, in the case of similar looking species, like the Sergeants, the book is extremely unhelpful. For example, on page 92, the females (not illustrated) of the Staff Sergeant and the very similar Small Staff Sergeant have been described in nearly identical terms. Beginners will find it challenging to imagine what they look like and to distinguish between the two.

For whatever reasons, some species that do not occur in the Garo Hills and are also not described in the book figure in the checklist. It would have been better if these had not been included in the checklist or marked.

The lack of records of some common butterflies like the Spotless Grass Yellow *Eurema herla laeta*, Small Grass Yellow *Eurema brigitta*, Club Beak *Libythea myrrha*, and Common Beak *Libythea lepita* in the Garo Hills is surprising. Similarly, it seems unusual that only two members of the Rings *Ypthima* sp. have been recorded from these hills. Clearly, much more work needs to be done.

The systematic section is followed by "Butterfly Hotspots in the Garo Hills", which includes 7 useful maps of the area. The Suggested Reading and Websites section is a useful compilation of books and sites that would take one beyond the scope of the present book. The Glossary and Abbreviations might have been more profitably placed at the beginning of the book, for the convenience of users. The "Checklist of the Butterflies of the Garo Hills" is a list of all butterflies recorded so far from the area. Finally, there are the Common Name and the Scientific Name indices. The latter should more appropriately have been called the Generic Names Index (for that is what it is), for if one is searching for a species name, it is not available. Given the irritating frequency with which genera are re-assigned, the species names index would have been extremely useful.

The inside of the back cover lists the organisations represented by the authors and sponsors. Interestingly, there is the Indian Foundation for Butterflies, which is described as a group of professional butterfly biologists and amateur naturalists who are involved in research on the natural history, ecology, conservation needs, and other aspects of the biology of Indian butterflies. Nowhere does it state that the organization has anything to do with the Government of India or state governments. If it is not a governmental or at least quasi-governmental organization, I am curious to know how the use of the name "Indian" was permitted. Normally, private organizations are not permitted to use "Indian" or "National" in their names, since this gives the impression of official sanction to the activities of that organisation.

In conclusion, the book is a useful addition to existing literature and it is hoped that the authors will look into the matters outlined above in the next edition of the book.

■ PETER SMETACEK

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2. HIMALAYA: MOUNTAIN OF LIFE by Kamal Bawa and Sandesh Kadur (2013). Ashoka Trust for Research in Ecology and the Environment, Bangalore. Size: 30.5 cm x 27.5 cm. 308 pp. Price not given. Hardback.

There are some areas in this world which will never stop fascinating you, and there are some people who will never stop impressing you with their knowledge, dedication, and single-minded pursuit of excellence. When the two come together, the results are expectedly of high quality. The book HIMALAYA: MOUNTAIN OF LIFE proves this on every page. Kamal

Bawa is a distinguished Professor of Biology at the University of Massachusetts-Boston and a Founder-President of the Bengaluru-based Ashoka Trust for Research in Ecology and the Environment (ATREE). He has published nearly 200 scientific papers and authored or edited 10 books and monographs. Prof. Bawa's primary interest is plant life. The other author, the much younger Sandesh V. Kadur is an award-winning wildlife photographer and cinematographer, with a passion for outdoors, wildlife, and conservation.

This lavish coffee-table book starts with a picture of a pensive-looking Golden Langur, one of the last large primates to be discovered in the Indian subcontinent, and perhaps the most beautiful species amongst its peers. The first 32 pages introduce you to the landscape, people, plants, and animals, not through any technical description but through wonderful images by Sandesh. Although titled HIMALAYA, the book mainly focuses on the eastern portion of this 2,400 km chain of mountains, considered to be the youngest mountain chain in the world. The Himalaya is the result of slow-motion collision of the Indian tectonic plate, part of the massive Gondwanaland, with the southern coastal edge of the Asian plate, resulting in the slow upward thrust of the land. This happened nearly 70 million years ago – a short time in the geological time frame. What it lacks in geological history is compensated by its rich biological wealth. The book celebrates the biological and cultural diversity of these majestic and mysterious mountains. It covers the region from central Nepal through Darjeeling Hills, Sikkim, Bhutan, and into the north-eastern Indian states of Arunachal Pradesh, Assam, and Nagaland – a subset of the whole Himalaya.

The Eastern Himalaya, which the book mainly deals with, is considered to be one of the 34 biodiversity hotspots of the world. These hotspots are the cradle of evolution and diversification of plant and animal life. Sadly, these hotspots are also areas that have lost 90% or more of their original habitats. Through large landscape images, this book showcases the spectacular richness of life in these mountains, and also points out to the destruction that is going on in the area mainly through human-related activities. The area that harboured and nurtured more than 200 distinct ethnic groups now faces an extinction crisis on an unprecedented scale. Thanks to large-scale cultural osmosis, many ethnic groups with their own traditions, dress, food, and languages are disappearing, and some are more threatened than the species on the IUCN Red List!

The book not only has wonderful pictures of habitats, species, people, landscapes, and rivers, it has superb maps and illustrations to add value to the document. Each habitat picture has an extended caption, full of scientific information written in layman's language. This book further proves that the best of science is written in simple language. I would say the images and captions complement each other, vastly improving the appeal of the book.

The book covers almost all major taxa, from flowers to fish, to birds and mammals. I am particularly delighted that the book includes fish diversity. Out of over 14,000 species of freshwater fishes of the world, more than 900 are recorded here. Fish diversity is the highest in lowland rivers, with species richness declining with increase in altitude. Unfortunately, Himalayan fish diversity is under tremendous biotic pressure from overfishing, pollution, and introduction of invasive species. Strangely, the protection of local fish heritage is an issue that does not come to the minds of decision makers and conservationists, although the fish gene pool is one of the most important components of our biological wealth. It is a classic case of 'out of sight, out of mind'.

As can be expected from two committed conservationists, the book ends with a chapter *Threats to Biodiversity*. It makes sad reading, but all is not lost yet. Given a chance, nature can bounce back and heal some of the damage that we have inflicted on the Himalaya. The question is: Will the decision makers who think only of 10% GDP growth, allow this?

Although large in size, I think this book is a "must buy" for anyone interested in the protection of this fragile corner of the world. Composite pictures of the Mount Everest's East Rongbuk Glacier (pages 280–281) showing that between 1921 and 2008, the glacier has lost 380 vertical feet of snow, should convince any decision maker that the Himalaya is crying out for conservation attention. Books like this show that emergency actions are required to save what is appropriately called the *Mountain of Life*.

■ ASAD R. RAHMANI

3. FAUNAL HERITAGE OF RAJASTHAN, INDIA Edited by B.K. Sharma, Seema Kulshreshtha, and Asad R. Rahmani (2013). Published by Springer. Volume 1: General Background and Ecology of Vertebrates; Volume 2: Conservation and Management of Vertebrates. Size: 15.5 cm x 24.5 cm. 313 pp. Price: Rs. 1,450/-. Hardback.

The state of Rajasthan is fascinating due to its history, culture, palaces of former kingdoms, and its peace-loving and colourful people with the elaborate and multihued turbans of the men and the catchy embroidery on the clothes of the women. Likewise, the landscape is enchanting, especially of the stark and beautiful Thar, the hills of the Aravallis, and the ravines and forest areas along the course of the Chambal river, some with unique flora and fauna. In spite of the arid and semi-arid harsh landscape, the wildlife of the state has managed to survive through the years due to the low human population density and the proactive protection afforded by certain communities, especially the Bishnois. However, since the last three to four decades, the wilderness and the wildlife have been facing increasing and severe threats, largely due to the increase in human population, the growth of towns and cities, mining, oil and gas exploration/extraction, and other human-related factors.

The publication under review is a document on the faunal wealth of the state and the conservation issues of the landscape and the wildlife – written by a number of authors, and edited by three editors. The publication comprises two volumes. The first is in four parts, the first of which gives a general introduction to the state, its physical and climatic features, biogeography, biodiversity (including fossil records), and the history of past and present conservation ethos in the state. The next three parts cover a range of taxa of the state, ranging from fish to mammals. There are also species-specific chapters, such as those on the Great Indian Bustard, Lesser Florican, White-naped Tit, and the Tiger. The second volume deals with the conservation and management issues of various taxa and their habitats, the taxa/sites covered are the Tiger in Sariska, small mammals of the hilly tracts, Aravalli Hills, Kumbhalgarh Wildlife Sanctuary, Thar Desert, the Gharial and Ganges River Dolphin in the Chambal, the two Ramsar sites of the state (Sambar Lake and Keoladeo National Park), wetland birds, Demoiselle Crane, Sarus Crane, and Smooth-coated Otter.

Though the purpose and quality of production is overall good, there are serious errors and flaws in the book, some being: a] the illustrations of all the fish species from numbers 12 to 36 do not match the names given in Table 6.1 (Volume 1). The first two of the eleven are correct, but I suspect there are mistakes in the rest from what I know of fish with my amateur knowledge, b) Again, as far as my knowledge of botany goes, the photographs in Figures 2.18 and 2.19 (Volume 1) have probably been interchanged, as the one in the former is definitely not *Commiphora wightii* (which has been wrongly spelt as *weighttii*), c) The photograph in Figure 10.2 (Volume 1) is that of the Common Sand Boa and not the Indian Rock Python, d) Though not a clear image, the image in Figure 2.94 (Volume 1) appears to be the Dalmatian Pelican (as the ones above) and not the Spot-billed, and e) the genus of *Cassia fistula* has been wrongly written as *Casia* in Figure 2.24 (Volume 1). Considering the errors detected from a casual perusal, and since I largely scanned those that are familiar or interests me, there is the possibility of more such errors.

When I picked up the publication to peruse it for review, I expected it to be basically a treatise on the different faunal groups of the state. Instead, in addition to some of this nature, there are chapters with accounts of single species, as mentioned earlier. Considering the title, I feel these should not have been included, and instead, more authoritative and extensive accounts of the different faunal groups could have been written. As for layout, there is quite a bit of waste of space by having larger than necessary figures and photographs, and having those which are unnecessary. For example, the 53 distribution maps for the raptors in Chapter 13 of Volume 1 occupy half a page each – these could instead be thumb-sized images positioned at the side of the text for each species as is the case in field guides. The need for having profile images of raptors, and also the many images of birds and other fauna in Chapter 2 is also questionable. A few representative ones and those of high quality could have been used, thus saving on paper and reducing the bulk of the book. Even if the inclusion of profile images was felt necessary, these could have been reduced to many small ones in each page/plate. I also found many of the maps of the state too gaudy for my liking (e.g., Fig. 1.1, in which the font sizes of the districts differ). What was the need to repeat the Foreword and Acknowledgments in the second volume? There is also scope for cutting down on text (with better editing), and images in Volume 2, for example the photos of the temples of the state and the movie star being taken to court/jail.

In spite of the errors and drawbacks, the publication is definitely an important contribution to the literature on the wildlife of the state, and its value will be enhanced once the errors and changes suggested in this review are addressed through a revised reprint or at least 'a reprint with corrections'. With all these, there could also be scope to reduce the two volumes into one compact volume.

■ RANJIT MANAKADAN

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MISCELLANEOUS NOTES

1. FIRST RECORD OF MELANISTIC INDIAN WOLF *CANIS LUPUS PALLIPES* FROM THE INDIAN SUBCONTINENT

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Aberrant colorations among animals are not uncommon. Two such most commonly recorded unusual colour phenomena are melanism and albinism. Melanism, a phenomenon of excessive synthesis of the melanin pigment, results in melanistic (black or dark brown) morphs of the animals, frequently observed in the wild (Anderson *et al.* 2009; Delibes *et al.* 2012). On the contrary, partial or total lack of the synthesis of melanin (leucism and albinism) is rare among wild animals, but commonly observed in domesticated or zoo animals. The white phenotypes lack evolutionary adaptive significance in nature (except in snow covered regions), and are therefore, usually eliminated from the natural populations (Caro 2005).

Recent advances in molecular genetics have revealed the evolutionary and ecological significance of colour polymorphism. Certain colour polymorphism even sheds light on the history of the lineages. For example, the gene mutations, introduced by dogs in the natural populations of Grey Wolf *Canis lupus* in North America resulted in evolution of melanistic morphs in the population. These dark-coloured wolves are common in boreal forests and extremely rare in tundra – where light coat coloured wolves are common. It seems to suggest the adaptive significance of dark coat colour in concealment during predation in the forests or indirect effect of some other important adaptations (Anderson *et al.* 2009).

The occurrence of melanistic phenotypes in mammals of the Indian subcontinent has been regularly reported in species such as Blackbuck *Antilope cervicapra*, Leopard *Panthera pardus*, Woolly Flying Squirrel *Eupetaurus cinereus*, Red Muntjac *Muntiacus muntjak*, Jungle Cat *Felis chaus*, Asian Golden Cat *Catopuma temminckii*, and Dhole *Cuon alpinus* (Bashir *et al.* 2011; Chakraborty and Agrawal 1977; Chakraborty *et al.* 1988; Hauxwell 1904; Inglis 1952; Morris 1936; Smith 1906). Although melanism has been frequently documented in canids, especially in Grey Wolves in North America (Anderson *et al.* 2009), no record of occurrence of melanistic *C. lupus* has been reported from the Indian subcontinent (Jhala 2013; Pocock 1941). Here, we give the first record of melanistic Indian Wolf *C. lupus pallipes* from the Indian subcontinent.

On September 26, 2012, the first author (AL) observed a black dog-like animal moving about 300 m from him in agricultural fields located at *c.* 5 km south-east of Mangalwedha (17° 30' N and 75° 26' E), Solapur district, Maharashtra. After brief observation, he realised that the behaviour of the animal was quite different from the usual behaviour of dogs. This increased the curiosity of AL, and he moved *c.* 40–50 m towards the animal, and crouched behind a tree to observe the animal, which was resting in a puddle. Except its black colour, with a white patch on the upper jaw and on the lower part of the chest between the forelimbs, the other features such as the longer snout in proportion to its head, the large, blunt upright ears, and tail almost straight with slight curvature at the middle to the distal end indicated that it was a wolf. Eventually, the wolf became aware of the presence of the author; it stood up and started moving away from him. During this time, another animal arrived at the scene – a wolf with normal coat colour. Both the animals engaged themselves in chasing and mounting, with the black wolf once attempted to mount the other wolf. These observations made the author more confident about his identification of the melanistic wolf.

Subsequently, we visited the area on November 13 and 14, 2012, to collect additional information. The area represents a typical Deccan plateau, where the terrain is flat with deep black cotton soil. The landscape is a mosaic of dryland and irrigated agriculture fields with scattered trees, such as Neem *Azadirachta indica* and Babul *Acacia nilotica* and thickets of *Prosopis juliflora*. Thickets of *P. juliflora* provide ideal resting and denning sites for the wolves. We interviewed three randomly selected shepherds and three farmers by showing photographs of the black wolf taken

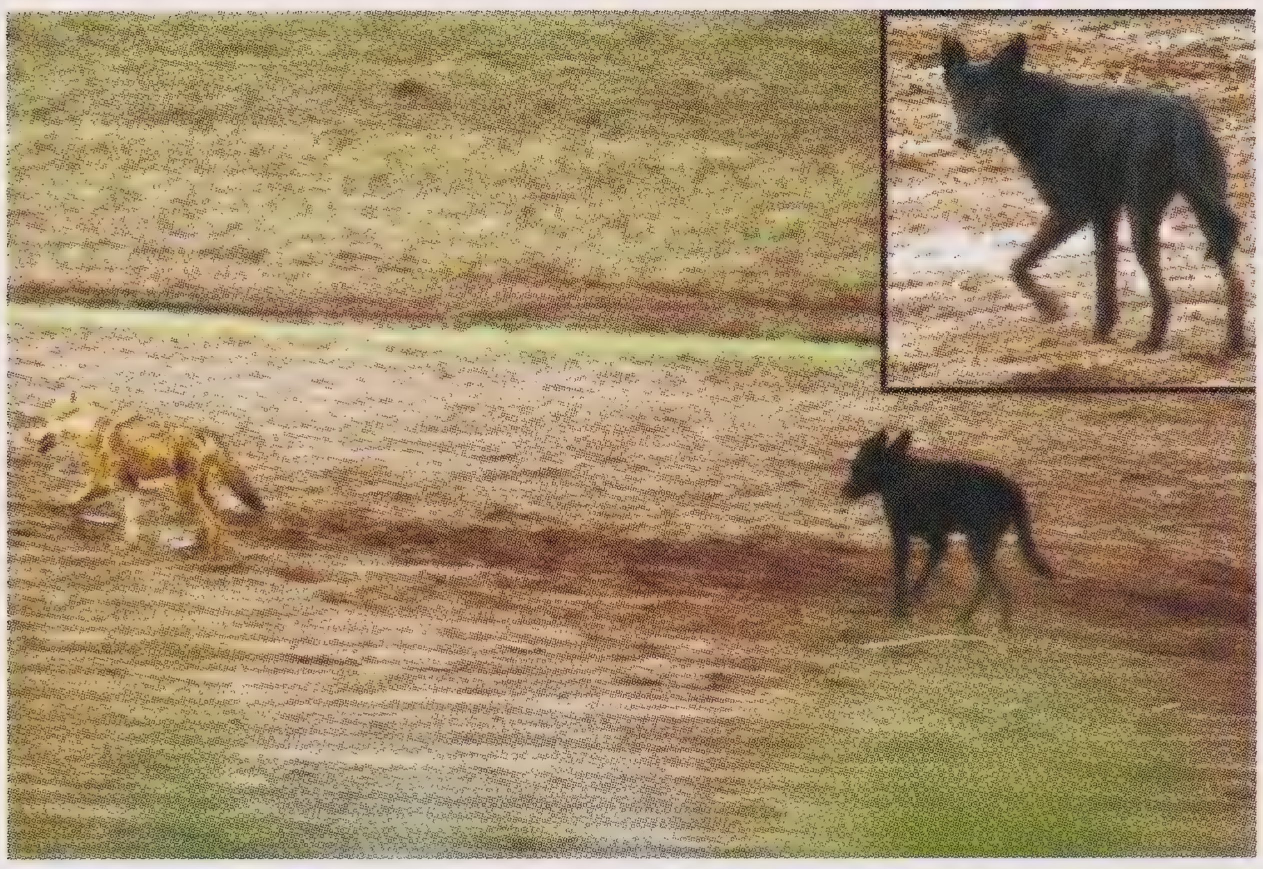

Fig. 1: The melanistic Indian Wolf *Canis lupus pallipes* with a normal coloured wolf in an agricultural field
Inset: a closer view of the black wolf

from the same area by the first author. They all agreed on the rarity of the occurrence of the black wolf. One of the shepherds, a very old man, said that this was the first time he was seeing black wolves in his 65–70 years of experience of shepherding in this region, and also mentioned the presence of two individuals – a male and a female in this area. The shepherds said that they had seen melanistic wolves frequently hunting blackbuck along with normal coloured wolves.

Anderson *et al.* (2009) have discussed in greater detail the evolution and adaptive significance of melanism in the North American Grey Wolf. They have revealed that the mutation in K locus in dogs gave rise to dominant K^B allele, leading to inheritance of black coat colour. They also postulated that this mutation might have arisen in Old World wolves before domestication, and then was lost from that gene pool and was again introduced in North American gray wolves through native American dogs. However, the occurrence of melanistic wolves in the Indian subcontinent, which is the oldest lineage of wolves (Sharma *et al.* 2004), challenges the hypothesis of complete disappearance of the gene responsible for the black coat colour from the gene pool of the Old World wolves. It may indicate the recent re-introduction of the gene from dogs to Indian wolves through hybridisation, or recurrence of an independent mutation in Indian wolves.

This report of melanistic wolf in the Indian subcontinent is of crucial scientific importance to reveal the mystery of the origin of K^B allele responsible for black coat colour in wolves and it could also provide deeper insight into the evolution of wolf-dog lineage.

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2. FIRST BREEDING RECORD OF THE LESSER ADJUTANT *LEPTOPTILUS JAVANICUS* (HORSFIELD, 1821) FROM BOKARO DISTRICT, JHARKHAND, INDIA

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Introduction

The Lesser Adjutant *Leptoptilus javanicus* is placed in Vulnerable category of the IUCN Red List for Birds (IUCN 2013). Its global population is decreasing rapidly, mainly because of habitat loss, anthropogenic pressures, decreasing wetland feeding areas, intensive fishing, and increased use of pesticides (Rahmani 2012). Earlier estimate of its global population was 5,000 (BirdLife International 2001; Hancock 1992), but based on extensive surveys it is now estimated between 6,500–8,000 or possibly more (BirdLife International 2013).

The Lesser Adjutant has an extensive distributional range across South and Southeast Asia. It is now presumed to be extinct in China (BirdLife International 2001, 2011). In India, it has been reported from many areas (Rahmani 2012), but its largest population is in Assam, West Bengal, and Bihar where it is found in fair numbers (BirdLife International 2013; Chaudhury 2000; Mishra *et al.* 2004).

In India, breeding of Lesser Adjutant has been recorded from Assam, West Bengal, Bihar, Odisha, Tamil Nadu, and Karnataka (Rahmani 2012). However, the maximum reports of breeding are from Assam (Barua and Sharma 2005; Choudhury 2000, 2006; Pawar and Birand 2002). A few (maximum of four in 2011) adult individuals of this adjutant have been sighted at Udhuwa Lake Bird Sanctuary in Sahibganj district, Jharkhand (Mishra 2004; Prakash *et al.* 2012), but there are no records of its breeding from the area. Other than these, there are only two sightings of *L. javanicus* from Jharkhand: Lohardaga district in western Jharkhand (Ball 1874) and a single individual in 2012 from Rangamatia, Saraikela-Kharsawan district (The Telegraph, June 13, 2010). In recent years, breeding of the species has been recorded from the states neighbouring Jharkhand, namely Bihar (Kumar and Choudhary 2010; Mishra *et al.* 2004), West Bengal (Jha 2006), and Odisha (Gopi and Pandav 2007).

During a road survey of the birds of Bokaro district, Jharkhand, between February 10–25, 2013, we recorded a total of 15 adult Lesser Adjutants and five nestlings in Ambadih Tola (23° 38' 54" N; 85° 53' 02" E) of Uttasara village, 6 km north of the Peterwar block. A small breeding

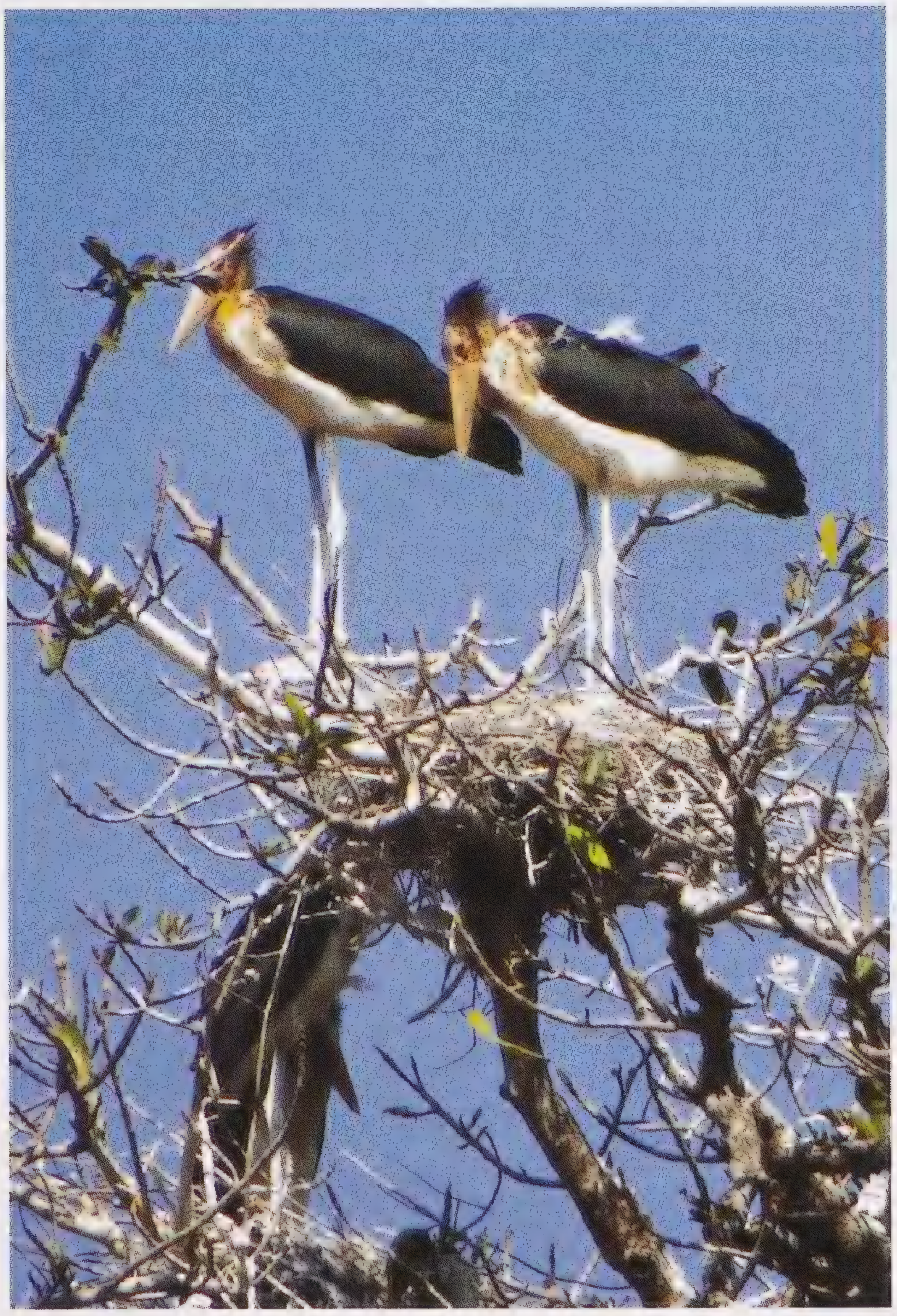

Fig. 1: 1st and 2nd nest of Lesser Adjutant on *Ficus benghalensis* in Uttasara village of Peterwar, Jharkhand

colony of three pairs had constructed three massive platform nests on the top of a *c*. 15 m tall *Ficus benghalensis* tree, located very close to human habitations. Local villagers said that nesting started in October 2012. Two nests had two nestlings each (Fig. 1), and the third had one nestling (Eds: photographic evidence provided). These nestlings were approximately three months old. Fledging was observed on February 20, 2013. There are bamboo plantations a few hundred metres away from the nesting site and the River Khajo flows about 5 km from the breeding site. There is also a large waterbody, Tenughat dam (38.13 sq. km), to the north of the nesting site with stretches of mudflats and wetlands, which would provide suitable feeding grounds for the species.

The species is known to the locals by the name *Khat-Khat*. They say that there used to be about 50 nests every year in the area prior to 1970, the birds mainly nesting on *Bombax ceiba*, but all of them suddenly left the place. About 20 individuals again started nesting in 2011, mainly on Tamarind *Tamarindus indicus*. The nesting site of the Lesser Adjutant needs to be protected, and also the wetlands of the area, so that this area becomes an important nesting and foraging site for the species in Jharkhand.

ACKNOWLEDGEMENTS

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3. FIRST RECORD OF LESSER WHITE-FRONTED GOOSE *ANSER ERYTHROPUS* FROM GUJARAT, INDIA

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The Lesser White-fronted Goose *Anser erythropus* is globally threatened (BirdLife International 2013); it breeds in the Taiga and Tundra, and winters in Iraq and in the southern and eastern lowlands of China. In India, it is a rare and vagrant winter visitor with sporadic records from Kashmir, Uttar Pradesh, West Bengal, Bihar, Assam, Rajasthan (Keoladeo National Park), and Maharashtra (Rahmani 2012). More recently, there have been single records from Maharashtra, Odisha, and Andhra Pradesh (Manakadan *et al.* 2011). There are no reports of the species from Gujarat (Rahmani 2012; Sen 2008; Tiwari 2013).

During a BNHS camp to the Little Rann of Kutch in December 2013, while exploring the north-eastern end of Nawa Talaw area (23° 13.47' N; 071° 45.39' E), I saw a gaggle of five geese at about 300 m distance that resembled Greylag Goose *Anser anser*, but were smaller and darker. On viewing through 10x42 binoculars and later spotting scopes (20x and 48x), it was identified to be Lesser White-fronted Goose based on two (adult) individuals that had white coloration at the margins of the bill. The birds were photographed (Eds: photographic evidence provided). This species was separated from the Greater White-fronted Goose based on the smaller size, shorter neck, smaller and shorter bill, the presence of a clear yellow eye-ring, and white at the base of the bill extending up to the forehead (see Grimmett *et al.* 2011; Manakadan *et al.* 2001; Rasmussen and Anderton 2012).

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4. SIGHTING OF BAILLON'S CRAKE *PORZANA PUSILLA* NEAR CHENNAI, INDIA

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We have been visiting Thenneri lake, 60 km south-west of Chennai, for the last six years. There is a small pond at Ayimicheri, about a kilometre off Thenneri. Pheasant-tailed Jacana *Hydrophasianus chirurgus*, White-breasted Waterhen *Amaurornis phoenicurus*, Common Moorhen *Gallinula chloropus*, Yellow Bittern *Ixobrychus sinensis*, Cinnamon Bittern *Ixobrychus cinnamomeus*, Black Bittern *Dupetor flavicollis*, and herons *Butorides striatus* and *Ardeola grayii* are commonly seen at this pond that rarely dries up. Towards the end of March 2012, we obtained a new record for the area. It was a small brown bird with dark brown and white spots on the upperparts, white bands on the rear underparts, and red eyes. Photographs were taken, and on checking field guides, it was identified as Baillon's Crake *Porzana pusilla*.

Baillon's Crake is mentioned as a scarce or occasional winter visitor in the Field Guide by Kazmierczak (2006).

Baillon's Crake *Porzana pusilla* (RM) Quail± 19 cm. *Occurrence*: Reed-beds and irrigated crops. *Breeding*: Gilgit and Kashmir; breeding reports(?) from Simla, Uttar Pradesh, Bihar, Nepal, and Kerala. *Winter*: Subcontinent; S. Andamans, Sri Lanka. ID: *Male* like male Little Crake, but has white paint-like smears above, barring on posterior underparts more extensive and distinct, and lacks red base to bill. *Female* duller (Manakadan *et al.* 2011).

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5. PHOTOGRAPHIC RECORD OF THE BUFF-BREASTED SANDPIPER *TRYNGITES SUBRUFICOLLIS* IN KERALA – FIFTH RECORD FROM THE INDIAN SUBCONTINENT

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The Buff-breasted Sandpiper *Tryngites subruficollis* breeds in the Arctic region of Canada and Alaska, and migrates to South America in winter. This species is a vagrant nearly worldwide, and records in the United Kingdom are attributed to windblown birds due to hurricanes in the West Atlantic (Mike Prince, pers. comm. November 2011). The species has been reported on four occasions from the Indian subcontinent: a specimen collected from Kalametiya lagoon, near Hambantota in Southern Province, Sri Lanka (Norris 1960); sight record from Trincomalee, Sri Lanka, in November 1974 by J.C. Sinclair (Phillips 1978); exceptional spring sighting from Harike, Punjab, India, in May 1996 (Robson 1996); and sighting of a single bird by Paul Holt from Santa Cruz, Goa, India, in November 2000 (Holt and Heil 2003).

The population of the Buff-breasted Sandpiper has undergone a decline due to widespread conversion of natural grasslands to agriculture. The Canadian Wildlife Service estimates that there are only about 15,000 birds in the world, and hence, it is classified as Near Threatened by the IUCN.

In this note, we report a record of the species from Madayipara, Kannur district, Kerala, India. Madayipara (12° 01' 46" N; 75° 15' 29" E) is a laterite hillock, situated at Madayi village near Payangadi town. To the north of Madayipara is the Ezhimala Naval Academy, to the west is the Arabian Sea, and to the south is a meandering river. Madayipara is a plateau, almost dry with a few trees and shrubs, a few rock pools, and two large ponds. It is known for its rich diversity of endemic and endangered flora, and also for migratory birds, some of which are known to overwinter.

While watching waders at Madayipara on October 30, 2011, we saw a small wader with yellow legs and pearly edged wings (Fig. 1), along with *c.* 200 Lesser Sand Plover *Charadrius mongolus*. The bird was smaller and slimmer than the plovers, with a short, pointed, stint-like bill. It was feeding along the side of some rock pools, not associating with the plover, and bobbing its head occasionally. The bird was not shy and we could approach it as close as 15 m, so we managed to get a few decent pictures. We watched the bird for about 30 minutes on that day, and again spotted it from November 1–3, 2011. The bird was not seen after these dates, despite several visits and intensive searches by us.

The bird resembled the Ruff *Philomachus pugnax*, but was smaller and had a shorter neck. The dove-like plain

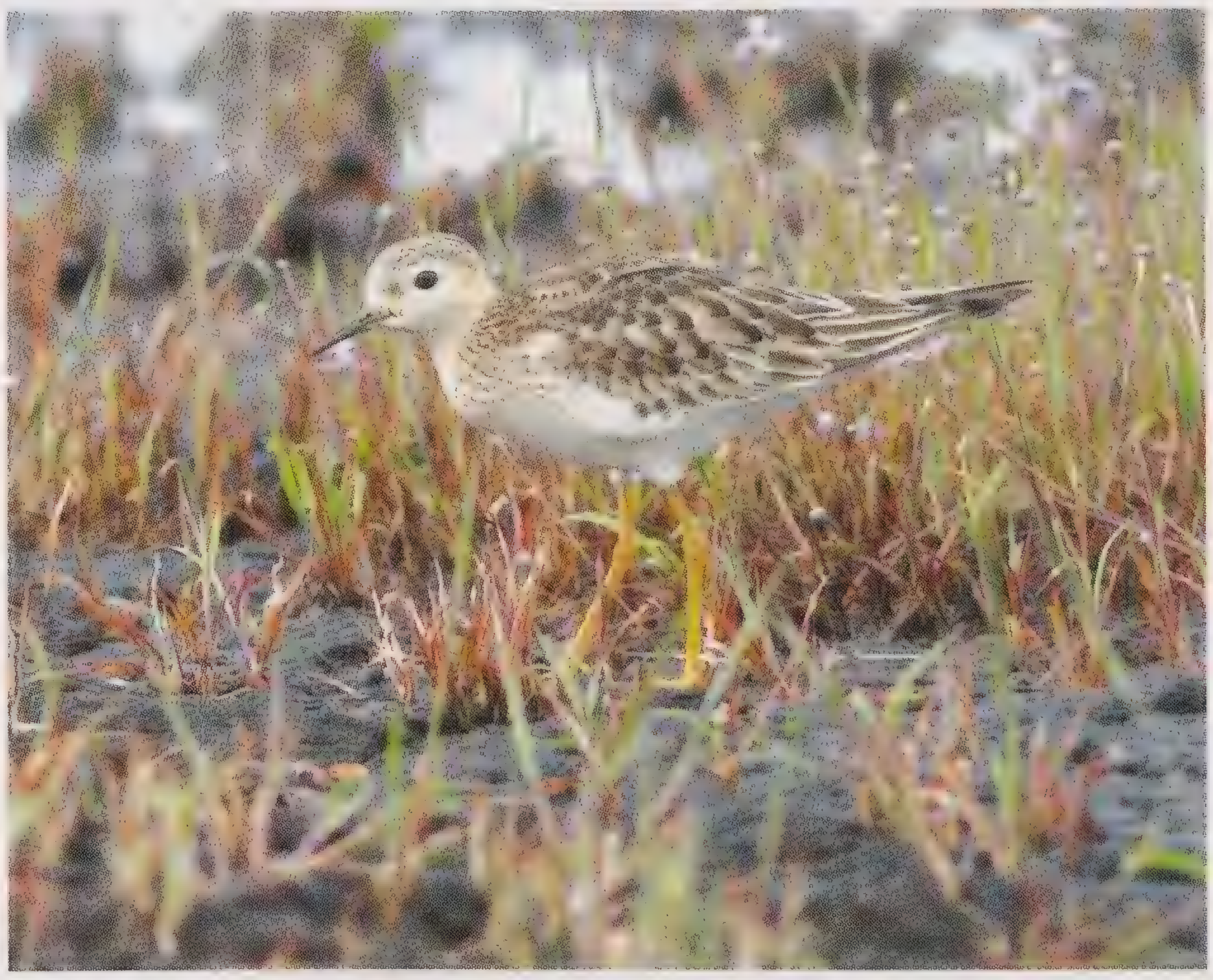

Fig. 1: Buff-breasted Sandpiper *Tryngites subruficollis* spotted at Madayipara on October 30, 2011

unmarked face showed a pale eye-ring; it had spots on the sides of the breast; and in flight, the underwing was white; there was no hint of white on the upperwings, tail, or rump. These features, in addition to the short and straight bill that was almost equal to the length of the head, and the yellow legs, were sufficient to shortlist it as the Buff-breasted Sandpiper, which was later confirmed by Indian and foreign expert birders to whom the photographs were circulated.

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6. USE OF RED-RUMPED SWALLOW *CECROPIS DAURICA* NEST BY YELLOW-THROATED SPARROW *GYMNORIS XANTHOCOLLIS*

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During summer, on May 30, 2009, while wandering near Beda village (25° 00' 52.7" N; 73° 09' 45.11" E) close to the southern end of Kumbhalgarh Wildlife Sanctuary, Pali district, Rajasthan, we observed a nest of the Red-rumped Swallow *Cecropis daurica* occupied by a Yellow-throated Sparrow *Gymnoris xanthocollis* on the underside of a large rock in a hill. The nest was pitcher-shaped and sheltered against rain and sunlight by the overhanging rock. The bird was resting in the nest and remained inside for nearly five minutes. When we approached closer, it flew off and perched on a nearby leafless *Butea monosperma* tree. We observed it through binoculars and found it had a conspicuous chestnut patch on each shoulder. Since the yellow throat-patch was missing, it was identified as a female. She came back to the nest within ten minutes of our leaving and entered it with some hesitation. We conducted a survey of the surrounding area and recorded two more mud nests within a 10 ha area, which were occupied by Yellow-throated Sparrows. In one case, around 16:00 hrs, a female sparrow was noticed entering a nest with an insect – an indication that the swallow's nest was being used by the sparrow to raise youngs.

The study area is a scrubby-woodland type habitat, with *Euphorbia caducifolia*, *Anogeissus pendula*, *Butea monosperma*, *Azadirachta indica*, *Acacia leucophloea*, and *Cassia auriculata* being common. There is a scarcity of old and large trees with cavities, which are the natural nesting sites of the Yellow-throated Sparrow (Ali and Ripley 2007; Ghose 1969). Probably for this reason, birds such as the Yellow-throated Sparrow are compelled to use alternative sites such as the nests of the Red-rumped Swallow for nesting. The nest location on the lower surface of large rocks in hills makes it difficult for snakes to approach the nests. The large size of the rocks and shade probably provide insulation against high temperatures.

ACKNOWLEDGEMENTS

The authors are very grateful to the officials of Kumbhalgarh Wildlife Sanctuary for providing assistance during the course of study.

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7. RECORD OF A BLACK-LEGGED KITTIWAKE *RISSA TRIDACTYLA* IN SOUTH-EASTERN RAJASTHAN, INDIA

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On December 11, 2012, I (along with my wife and two others) made an early morning visit to Soorwal dam, 7 km from Ranthambhore, Rajasthan. On arrival, we drove along the dam scanning for waterbirds, and also looking out for birds in the surrounding fields and those passing by. Except for several River Tern *Sterna aurantia*, one adult and one 1st winter Pallas's Gull *Larus icthyaetus*, there appeared to be no other waterbirds on this part of the lake.

At around 09:00 hrs, I noticed a small gull flying towards us that had a distinctive black 'W' pattern across the wings and a black tail tip indicating it was a 1st winter bird. I immediately thought this bird was interesting and merited close scrutiny. Of the smaller gulls that occur in the Indian region, I knew that 1st winter Mew *Larus canus*, Brown-headed *L. brunnicephalus*, Black-headed *L. ridibundus*, and Slender-billed Gull *L. genei* all had a very different upperwing pattern. Little Gull *Larus minutus*, which also has a black 'W' pattern on the wings in 1st winter plumage was a possibility. However, as it lacks the black nuchal collar, is a distinctly smaller bird, and has a very different flight action, I quickly discounted it. I instinctively felt the bird I was watching was a Black-legged Kittiwake, a gull that I was quite familiar with from my experience in the Western Palearctic. But it was strange that the bird was in inland Rajasthan, since Black-legged Kittiwake is a pelagic/maritime species. As the bird came closer, I was able to take a few pictures as it flew past and before it flew off from the area.

From the observations through binoculars and telescope, and from reviewing the images captured on camera, I noted the following features: a small and slender dark bill, dark legs and feet, and a dark eye with a slight grey smudge above it and a black crescent smudge behind it fading at the top and bottom. The bird had a black collar and behind that an all-light grey mantle which continued onto the base of the wings, forming a grey triangle. Contrasting with the grey back, the tail was white and slightly forked and tipped black. The upperwing pattern was a white triangle formed from the inner primaries and secondaries bordered on the leading edge by black outer primaries, which narrowed from the black primary tips to the carpal joint. Here the black of the leading edge of the wing continued as a quite thick dark bar running diagonally back towards the base of the trailing edge of the inner secondaries. However, it stopped short of the trailing edge of the secondaries, which was all white. The grey of the mantle continued out to the leading edge of the wing and ran back to the rump bordered by the black diagonal bar. The secondary coverts running inside the black diagonal bar were also the same tone of grey as the mantle. The underwing appeared all white, apart from black primary tips.

On referring to Grimmett *et al.* (2011), I found that none of the smaller gulls regularly recorded in India had this suite of features, and also found that the Black-legged Kittiwake was a vagrant coastal species to the Indian region. Later, I was able to go online and confirm that my earlier tentative identification was correct. On returning to UK, I tried to find out how frequently vagrant Black-legged Kittiwake were recorded in India, and my limited desk research suggested they were very infrequent and almost always coastal. Further enquiries led to the discovery that there were two other recent sightings of the species in India and several pictures of them were featured on the Oriental Bird Club Images database (www.orientalbirdimages.org): On November 25, 2012, a 1st winter bird was seen at Alibag, Maharashtra, (http://orientalbirdimages.org/search.php?Bird_ID=966&Bird_Image_ID=69327&p=12) and on November 30, another was seen near Majuli Island, Assam. (http://orientalbirdimages.org/search.php?Bird_ID=966&Bird_Image_ID=68197&p=13).

In addition, I was later advised that Little Gull has also been photographed in Goa – with the record featured in Ali and Ripley (1987).

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8. *PANGASIANODON HYPOPHTHALMUS* (SAUVAGE, 1878) – AN ALIEN CATFISH IN MUVATTUPUZHA RIVER, KERALA, INDIA

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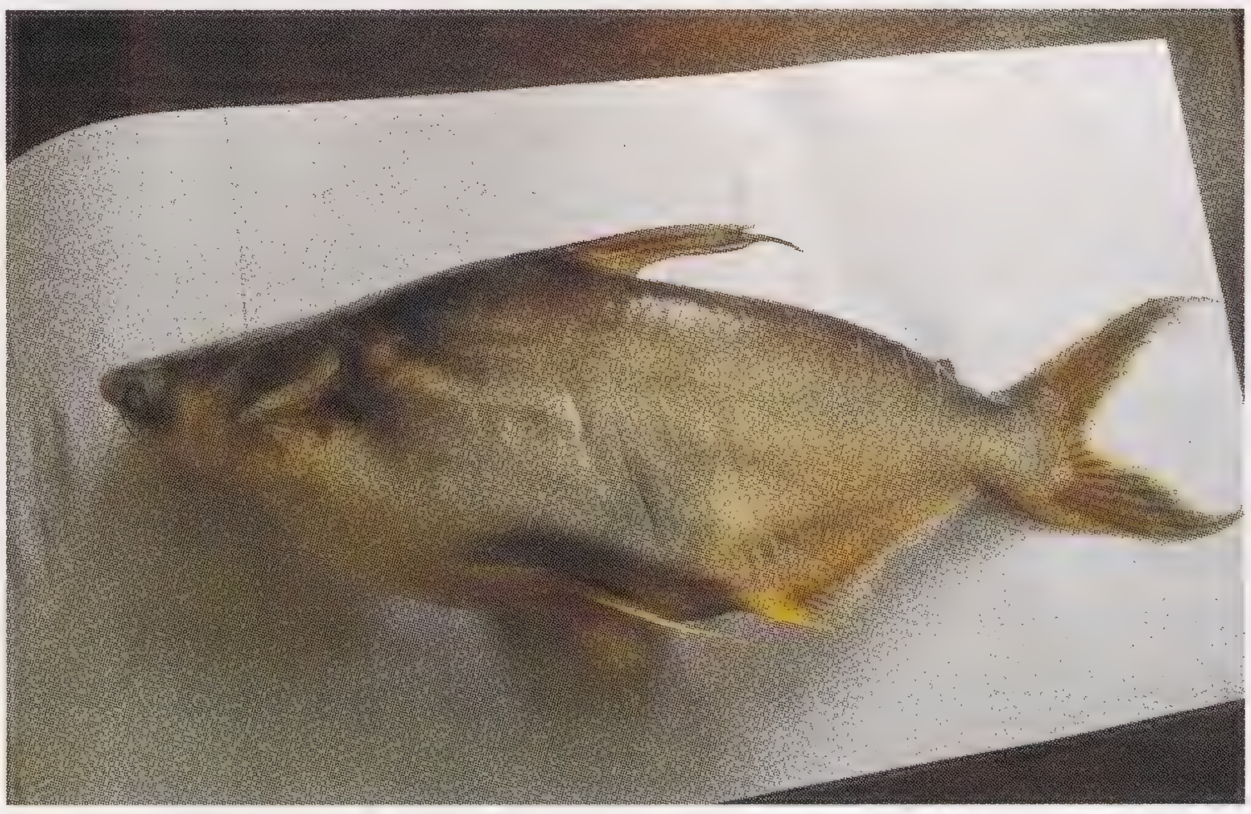
Introduction

While conducting surveys on fish diversity in Muvattupuzha river, Kottayam district, Kerala, an exotic catfish *Pangasianodon hypophthalmus* (Order Siluriformes, Family Pangasiidae), was collected through cast net from Brahmamangalam (9º 48' 58" N; 76º 25' 26" E) during June 2011. Catfishes of the genus *Pangasianodon* are abundant in the natural waterbodies in Southeast Asia (Gustiano 2003; Roberts and Vidthayanon 1991). The natural range of *P. hypophthalmus* is limited to the lower Mekong Basin, which includes Cambodia, Lao People's Democratic Republic (=Laos), Thailand, and Vietnam, and the Chao Praya river in Thailand (Thuong 2008). It is commonly called 'Tra' in Vietnam and Basa or Pangas catfish in the world market. *P. hypophthalmus* is cultured and marketed as an economically important food fish. Young fish are also kept in home aquaria and known by the trade name of Iridescent Shark. *P. hypophthalmus* has been introduced to different countries like China, Philippines, Taiwan, Indonesia, Malaysia, Guam, Bangladesh, and India for aquaculture (www.fao.org). It is an omnivore, feeding on crustaceans, molluscs, plant debris, and small fishes. It is well-adapted to low O_2 water and can survive on a diet low in fish meal.

According to Lakra and Singh (2010), *P. hypophthalmus* was introduced to India during 1997. West Bengal is the main centre of *P. hypophthalmus* seed production in India and a bulk of it is being sent to Andhra Pradesh and the rest to Odisha, Tamil Nadu, Maharashtra, Kerala, Karnataka, Bihar, Rajasthan, and Uttar Pradesh for aquaculture and aquarium trade. According to Lakra and Singh (2010), the culture and hatchery sites of *P. hypophthalmus* in India have been found to be close to open waters, and hence there exists a chance of its escape. Escapee fish have been recorded from wetlands of West Bengal, as well as Kolleru lake area of Andhra Pradesh. Fish culture is spreading quickly in India, and it is not restricted to Andhra Pradesh and West Bengal, but has extended to other coastal areas, including hotspots of the Western Ghats, and in the northern and north-eastern parts of the country. *P. hypophthalmus* has the potential to mature and breed naturally in the wild, and hence, escapee fish may colonise and form feral populations in different agro-climatic conditions, impacting the ecosystem and in turn affecting the biodiversity. Alien fish species have been brought into India intentionally or otherwise for the purpose of aquaculture, aquarium trade, therapeutic value, research, and biological control. *Oreochromis mossambicus*, *Clarias gariepinus*, *Gambusia affinis*, and *Poecilia reticulata* are some of the introduced forms in Kerala. The spread of alien fish is associated with habitat alterations, trophic alterations, introduction of parasites, pathogens and diseases, genetic deterioration, and a drop in local fish biodiversity (Benigno 2001; Lakra *et al*. 2008; Singh and Lakra 2006). According to Casal (2006), very few reports emphasise the importance of alien species in aquacultural production enhancement on a sustainable basis, and most have highlighted irreparable losses that can adversely impact fish production and food security at large. In view of the above facts, there is an urgent need to regulate the introduction of alien species into our country.



Scale: 1cm = 2.7 cm

Fig. 1: *Pangasianodon hypophthalmus*

Below, we provide the morphometrics of a single specimen of *Pangasianodon hypophthalmus* collected from the Muvattupuzha river in Kerala.

Description

Body elongated and compressed. Head relatively small. Head Length (HL) 4 cm in Standard Length (SL). Mouth subterminal. Eyes large, placed in anterior half of head, partly

Table 1: Biometrics of *Pangasianodon hypophthalmus* (Sauvage 1878)

Sl. No.	Morphometric Characters	in cm
1	Total Length	37.3
2	Standard Length	29.2
3	Body Depth	8.5
4	Head Length	7.3
5	Head Depth	5.9
6	Head Width	5.1
7	Snout Length	2.2
8	Eye Diameter	1.3
9	Inter Orbital Width	4.4
10	Pre Dorsal Length	12
11	Post Dorsal Length	17.6
12	Pre Pectoral Length	6.5
13	Pre Ventral Length	13.7
14	Pre Anal Length	17.7
15	Caudal Length	4.5
16	Caudal Depth	3.6
17	Dorsal Fin Length	6.1
18	Dorsal Fin Base	2.1
19	Pectoral Fin Length	4.6
20	Pectoral Fin Base	1.4
21	Ventral Fin Length	4.2
22	Ventral Fin Base	1.4
23	Anal Fin Length	3.7
24	Anal Fin Base	8.7
25	Caudal Fin Length	7.7
26	Caudal Fin Base	3.6
	Meristic Characters Fin rays	Numbers
1	Dorsal	I/7
2	Pectoral	I/9
3	Ventral	i/7
4	Anal	30
5	Caudal	19

on the lower surface of the head behind corner of mouth. Eye Diameter (ED) 5.62 cm in HL and Inter Orbital Width (IOW) 1.66 cm in HL. Snout bluntly pointed and its length 3.1 cm in HL. Nostrils widely separated. Depth of body 3.44 cm in SL. There are two pairs of barbels. Maxillary barbel nearly 1.6 times longer than mandibular and runs along lower margin of eye, extending to operculum; black in colour. Mandibular barbel smaller, extends to middle of eye. From anterior tip of dorsal fin base, body is slightly arched. Operculum extends to pectoral fin base.

Dorsal fin commencing slightly in front and opposite to pelvic fin, with a serrated spine and 7 soft rays. First dorsal ray longest. Adipose dorsal fin short, a little anterior to caudal peduncle. Pectoral fin with strong serrated spine and 9 rays. Pectoral spine stronger than dorsal spine. Ventral fin has 8 rays, and its origin is opposite the 3rd dorsal fin ray. Anal fin long with 30 rays, extending up to caudal peduncle. Caudal fin forked, with 19 rays.

In specimens preserved in formalin, dorsal and lateral sides of *Pangasianodon hypophthalmus* are grey. Belly silvery. Dorsal fin grey. Base of pectoral, anal, and caudal fins yellow. Anal fin rays dark.

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9. *YPTHIMA KEDARNATHENSIS* SINGH – NEW SYNONYM OF *YPTHIMA SAKRA* MOORE (NYMPHALIDAE: SATYRINAE) FROM GARHWAL HIMALAYA, INDIA

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Introduction

The genus *Ypthima* Hübner is represented by about 100 species distributed in the Palaeotropical and East Palaearctic regions. Most of the species of this genus are known to exist in Western China, Burma (now Myanmar), Assam, Bhutan, Sikkim, Nepal, and Taiwan, some are distributed in Africa, including Madagascar, and a few extend to the South Pacific Islands and Australia (Shirozu and Shima 1979). Marshall and de Niceville (1883) separated the Indian species into two groups on the basis of presence or absence of the male brand. Besides male brand, Moore (1890, 1892) also took into consideration the number of ocelli on the underside of the hindwings and assigned various species in the genera *Thympia*, *Kolasa*, *Nadiria*, *Pandima*, and *Lohana*. Elwes and Edwards (1893) revised the genus *Ypthima* and gave an account of the valva of male genitalia of 47 species. Evans (1932) divided the genus *Ypthima* into four groups to accommodate Indian species. His grouping was mainly based on wing markings on the underside of the hindwings. Talbot (1947) followed Evans for the grouping of Indian *Ypthima*. Shirozu (1960) made an attempt to distinguish the natural group of the Formosan *Ypthima* by taking into account the structure of the male genitalia. Eliot (1967) published an account of 14 species of the *sakra* section of this genus, whereas Hiura (1969) discussed natural groups of Japanese, Korean, and Formosan *Ypthima* based on the male genitalia. Shirozu and Shima (1979) examined 73 species from Asia, South Pacific Islands, and Australia, and studied the male and female genitalia of 53 described species, besides the morphological characters of all the 73 species.

Results and Discussion

Sharma (1998) studied 54 species of the Subfamily Satyrinae (Nymphalidae) of north-west India, out of which 16 species belong to genus *Ypthima* Hübner. The 16 species, represented by 560 examples, are referable to seven species groups, namely *philomela*-group (*lisandra* Cramer, *singala* Felder, *marshalli* Butler, *baldus* Fabricius, *indecora* Moore, *sarkaghatensis* Rose & Sharma), *sakra*-group (*nikaea* Moore, *uemurai* Rose & Sharma, *hannyngtoni* Eliot, *sakra* Moore), *huebneri*-group (*kasmira* Moore, *huebneri* Kirby), *obscura*-group (*inica* Hewitson), *asterope*-group (*asterope* Klug), *nareda*-group (*nareda* Kollar), and *newara*-group (*newara* Moore). *Ypthima* species are highly variable in wing maculation, and the conspecificity of all the species is verified on the basis of genitalic studies (Rose and Sharma 1998).

Elwes and Edwards (1893) pointed out that owing to a lot of variations, different species of the genus *Ypthima* Hübner were difficult to identify/separate and the genus remained for many years a stumbling block to lepidopterists. Eliot (1992) has also recommended that the males admit of ready identification from the characteristic forms of their genitalia.

Singh (2007) mentioned that the three apical ocelli on the underside of hindwing in *Ypthima kedarnathensis* Singh have an intervening yellow band which is a common characteristic of *Ypthima nikaea* Moore. However, Rose and Sharma (1999) segregated 29 males and 2 females as *Y. nikaea* Moore on the basis of distinct brown submarginal transverse fascia and apical ocelli having intervening yellow band on underside of the hindwings. The whole sample was collected from Mussoorie where this species shares its habitat with a closely allied species *Y. sakra*. Fujioka (1970) reported that these two species fly together in Nepal. Besides female genitalic differences, these two species can be separated on the basis of androconia, and uncus and tegumen of the male genitalia.

Singh (*loc. cit.*) described a new species *Y. kedarnathensis* from Kedarnath Musk Deer Reserve in Garhwal Himalaya and compared wing maculation of the species with *Y. sakra* Moore and *Y. nikaea* Moore (Table 1), on which I have remarked. Singh (*loc. cit.*) has found additional ocellus in interspace 4 (M_2) on the dorsal side of the hindwing, and minute ocellus in interspace 4 (M_2) attached to the inner side of the ocellus in interspace 5 (M_1) on the ventral side of the hindwing. All the three apical ocelli in interspaces 4 (M_2), 5 (M_1) and 6 (Rs) are attached and have an intervening yellow band. Rose and Sharma (1999) have also found such individuals having additional ocellus in interspace 4 (M_2) on the dorsal side of the hindwing and on the ventral side a minute ocellus in interspace 4 (M_2) attached to the inner side of the ocellus in interspace 5 (M_1). According to Moore (1857), absence of a yellow intervening band between the apical ocellus on the underside of the hindwings

Table 1: Distinguishing features in wing pattern between *Ypthima sakra*, *Y. nikaea* and *Y. kedarnathensis* Singh

S. No.	Character	*Y. sakra* Moore	*Y. nikaea* Moore	*Y. kedarnathensis* Singh	Author's Remarks
A	Wing span	48–55	45–52	44–45	*Y. sakra*=48–50 mm (73♂, 22♀); *Y. nikaea* =26.0 mm (29♂, 2♀); Sharma (1998)
B	Upperside				
1.	Wing colour	Umber brown, terminal margins of wing darker	Dark brown	Dark brown	Upperside brown in *Y. sakra* & *Y. nikaea* (Sharma 1998)
2.	Forewing	Sub-apical ocellus large, oval bipupilled, very slightly oblique	Sub-apical ocellus smaller than in *Y. sakra*, oval bipupilled	Sub-apical ocellus smaller than in *Y. sakra*, oval bipupilled	Sub-apical ocellus varies in size even within the same species
3.	Hindwing	Four similar unipupilled rounded ocelli present, pre-apical and tornal ocelli frequently absent or faintly marked, the last when present always minute. [Pre-apical ocellus when present is on space 5 (between V5 and V6)]	Two sub-anal ocelli (male sometimes has one). Pre-apical and tornal ocelli frequently absent or faintly marked, the last when present always minute. Pre-apical ocellus when present is on space 5 (between V5 and V6)	Four similar unipupilled rounded ocelli present. Pre-apical ocellus faintly or sharply marked but always present on space 4 (between V4 and V5). Tornal ocelli frequently absent or faintly marked, but when present always minute.	In *sakra*-complex, ocelli vary in size and number (maximum 5), ocellus in Cu1a largest. Conspecificity of individuals showing variations in wing maculation can be confirmed on the basis of genitalic studies only (Sharma 1998; Rose & Sharma 1999)
C	Underside				
1.	Wing colour and pattern	Underside yellow to ochraceous brown, thickly irrorated by transverse, short-dark brown striae	Grey with numerous brown striae	Yellowish with numerous short brown striae	Underside coarsely striated with yellowish brown in *Y. sakra* and *Y. nikaea* (Sharma 1998)
2.	Forewing	Encircling yellow ring of pre-apical ocellus broader. Sometimes a second very much smaller, obscure median ocellus is present	Encircling yellow ring of pre-apical ocellus sharply defined.	Encircling yellow ring of pre-apical ocellus sharply defined.	Encircling yellow ring in *sakra*-complex broader and sharply defined as compared to dorsal side of ring
3.	Hindwing	5 ocelli	5 ocelli	5+1=6 ocelli	Additional minute ocellus in *Y. kedarnathensis* is a variation, confirmed on basis of male genitalia of holotype
		2 pre-apical ocelli large, geminate, encircled in a common yellow-ring (do not have a yellow band between them). Posterior 3 ocelli in echelon with the 2 apical ocelli, with distinct ridges, tornal ocellus bipupilled	2 apical ocelli large and have a yellow band between them. Posterior 3 ocelli arranged in a linear series from anal angle, tornal ocellus bipupilled.	3 apical ocelli present and their pupils form a 135 degree angle directed towards apex; all three apical ocelli have a yellow band between them. None of the three apical ocelli larger than the other three posterior ocelli. However, middle apical ocellus larger than the other two apical ocelli (which are reduced), and as big as middle ocellus of the three posterior ocelli. Posterior 3 ocelli arranged in a linear series from anal angle, tornal ocellus bipupilled.	In *sakra*-complex, actual number of ocelli on ventral side is 5 and 6th reduced ocellus in M_2 (interspace 4) is a variation, confirmed on basis of male genitalia of holotype; and *Y. kedarnathensis* may be synonymised under *Y. sakra.*

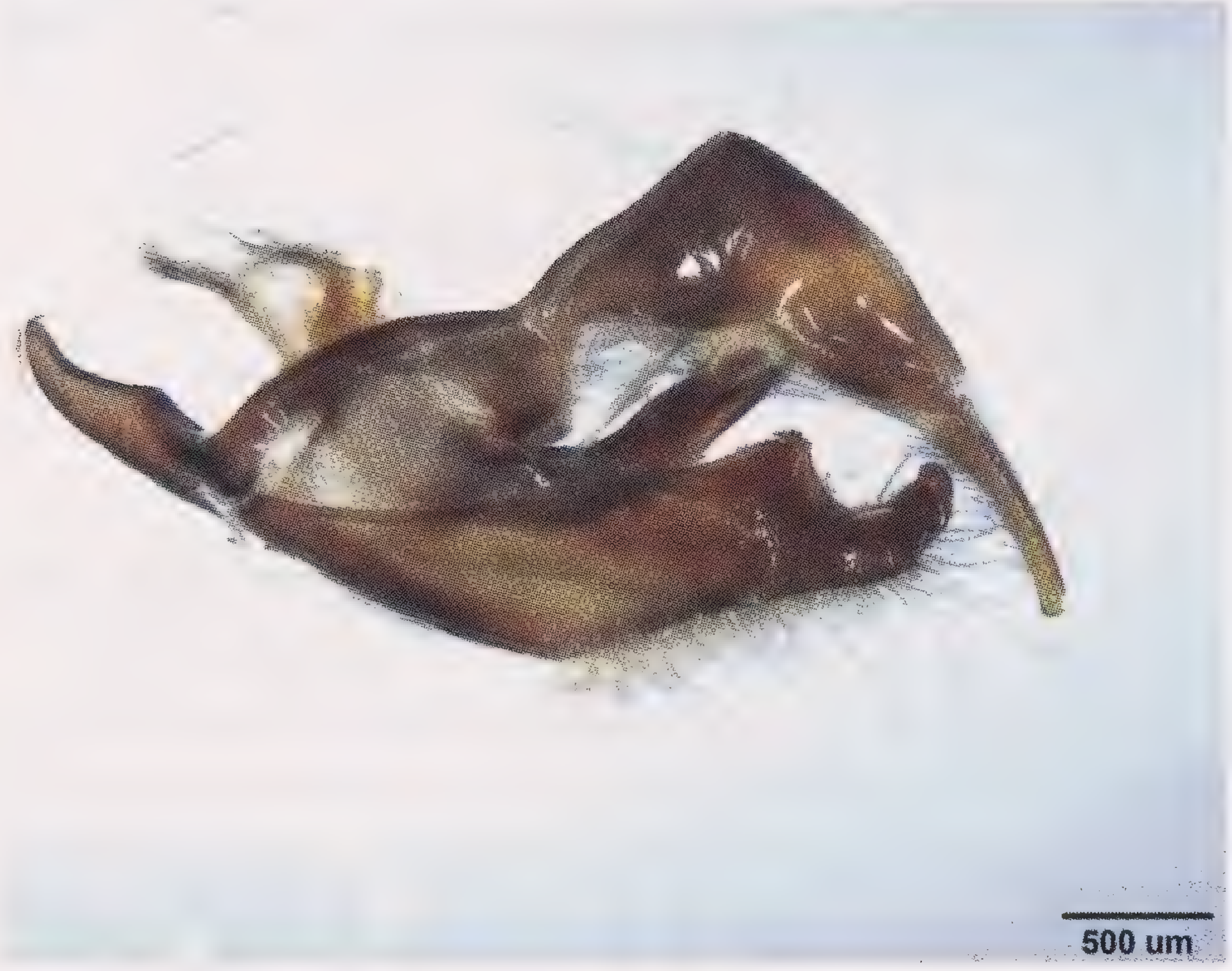

Fig. 1: Male genitalia of Holotype of *Y. kedarnathensis*

is a test character of *Y. sakra* as has also been stated by D'Abrera (1985) and mentioned by Singh (*loc. cit.*). Rose and Sharma (*loc. cit.*) observed that geminated condition of these apical ocelli on the underside of the hindwings is quite variable, even in individuals collected from the same locality (Mussoorie) on the same date. In 62 individuals, there is a single outer ring, while these ocelli are split in the remaining 33 individuals on the hindwing underside. In four individuals there is an additional ocellus in interspace 4 (M_2) attached to the inner side of the ocellus in interspace 5 (M_1). When the genitalia of these variable individuals were studied, it was found conspecific with *Y. sakra.* Singh (*loc. cit.*) has not studied the genitalia of the new species, which is recommended by the abovementioned authors to confirm the conspecificity of the species.

I studied the male genitalia of the holotype specimen of *Ypthima kedarnathensis* Singh in the laboratory of Entomology Department, Forest Research Institute, Dehradun, where the holotype and paratypes of *Y. kedarnathensis* are deposited. I found the structures such as uncus, tegumen, vinculum, appendices angulares, saccus, juxta, aedeagus, and valva of the male genitalia (Fig. 1) of *Y. kedarnathensis* to resemble the male genitalia of *Y. sakra.* Hence, I suggest that the newly described species, *Y. kedarnathensis* may be synonymised under *Y. sakra.*

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10. *CUCUMIS DIPSACEUS* EHRENB. EX SPACH (CUCURBITACEAE): A NEW RECORD FOR KARNATAKA, INDIA

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Introduction

Genus *Cucumis* L. is represented by 32 species worldwide (Kirkbride 1993). Chakravarty (1982) reported six species for India, after which Sarvalingam *et al.* (2010) added one more species, i.e., *C. dipsaceus* from Maruthamalai foothills, Tamil Nadu. Ghebretinsae *et al.* (2007) merged five genera, namely *Dicaelospermum* C.B. Clarke, *Cucumella* Chiov., *Mukia* Arn., *Myrmecosicyos* C. Jeffrey, and *Oreosyce* Hook. *f.* under *Cucumis* on the basis of molecular phylogenetic studies. With this enlarged circumscription of the genus, *Cucumis* is now represented by 52 species worldwide (Mabberley 2008). Of the five merged genera, *Cucumella*, *Mukia*, and *Dicaelospermum* are found in India. In India, *Cucumella* is represented by two species, namely *C. ritchiei* (Chakrav.) C. Jeffrey and *C. silentvalleyi* Manilal, T. Sabu & P. Mathew (Kirkbride 1994). The genus *Mukia* is represented by three species, namely *M. javanica* (Miq.) C. Jeffrey, *M. leiosperma* (Wight & Arn.) Wight, and *M. maderaspatana* (L.) M. Roem (De Wilde and Duyfjes 2006). The genus *Dicaelospermum* with one species, *D. ritchiei* C.B. Clarke, is endemic to the Western Ghats. The merging of the above species in *Cucumis* increases the species count to thirteen (Sutar *et al.* 2013).

Cucumis dipsaceus is possibly native to Sudan and southern Egypt, and occurs widely in different parts of Africa, America, and West Indies (Kirkbride 1993). We collected it from two sites in India, along the road around Mysore (12° 20' 875" N, 76° 40' 207" E; 716 m), Karnataka, and at the foothills of Maruthamalai hill in Tamil Nadu (11° 02' 660" N, 76° 51' 649" E; 573 m). The specimens were deposited in the herbarium of the Botany Department, Shivaji University, Kolhapur (SUK). The collection from Mysore forms the first record for Karnataka, which extends the distribution of this species northwards. We give a detailed description and illustration of the species below for easy identification.

Cucumis dipsaceus Ehrenb. *ex* Spach, Hist. Nat. Vég. (Spach) 6: 211. 1838.

Annual, climbing, monoecious, scabrous herb. Stem weak, quadrangular, grooved, herbaceous, branched, hairy. Leaves simple, alternate, exstipulate, cordate-orbicular, petiolate; petiole 4–9 cm long; lamina 8–14 x 5–14 cm, angular to shallowly-lobed, hairy on both surfaces, base cordate, apex acute, margin serrate-denticulate. Tendril simple, pubescent. Inflorescence: male flowers borne in cluster of 3–5 per axil on main branch; female flowers borne solitarily on secondary branch from 1st–3rd node. Male flower: 1.2–1.3 x 2.4–2.5 cm, actinomorphic, yellow; pedicel 10–13 mm long. Hypanthium *c.* 7 mm long, turbinate to

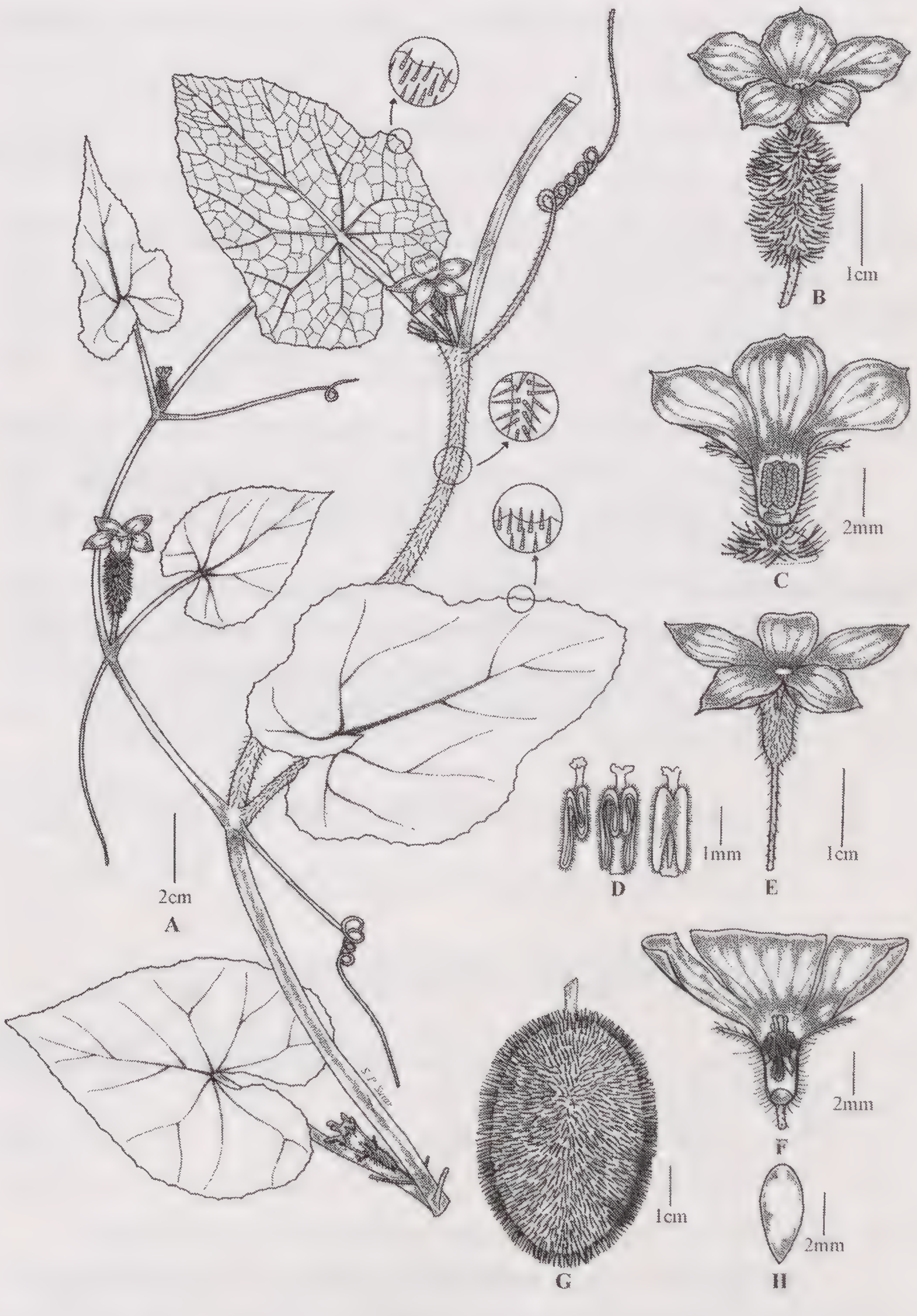

Fig. 1: *Cucumis dipsaceus* Ehrenb. ex Spach
A. Twig; B. Female flower; C. L.S. of female flower; D. Stamen; E. Male flower, F. L.S. of male flower, G. Fruit; H. Seed

campanulate, pubescent on both sides; calyx teeth *c.* 3 mm. Corolla yellow, campanulate; lobes 12 x 7 mm, ovate, apex obtuse, wavy margin, hairy on both sides. Stamens three: one monothecous, two bithecous, attached to the calyx tube 0.5–1 mm above the base, coherent to each other; anther lobes *c.* 3 mm long, straight, dorsifixed, ciliate, dehiscing longitudinally, extrorse, appendaged; filament *c.* 1 mm long, hairy; connective projection *c.* 1 mm long, bilobed. Pistillode *c.* 1 x 1 mm, globular. Female flower: 2.3–2.5 x 2–2.2 cm, actinomorphic; pedicel *c.* 5 mm long; hypanthium tube *c.* 3 mm long, turbinate to campanulate, hairy on both sides; calyx teeth *c.* 2 mm long. Corolla same as of male flower. Ovary *c.* 1.2 x 1 cm, ovoid to oblong, densely aculeate, 3-locular with many horizontal ovules; style *c.* 1 mm long, glabrous; stigma *c.* 2 x 2 mm, 3-lobed, papillate; disc *c.* 1 x 2 mm. Staminodes 3. Fruit: 5–7 x 3.5–4 cm, non-dehiscent, oblong, apex blunt, initially green turns pale yellow after maturity, many-seeded, densely aculeate, aculei 5–7 mm long. Seed: 4–5 x 2 mm, oblong-obovate, compressed, non-beaked, emarginate, grey-white, apex acute, funicle caduceus (Fig. 1).

Chromosome number: 2n = 24 (Kirkbride 1993; Singh and Yadava 1984).

Flowering & Fruiting: July to January.

Specimens examined: INDIA: Tamil Nadu, Coimbatore dist, Maruthamalai hill, 12.xi.2009, *Sutar 68* (SUK); Karnataka, Mysore, 24.xi.2010, *Sutar 95* (SUK).

Distribution: Africa, North and South America, Saudi Arabia, West Indies, and India.

Note: It grows along roadsides in wastelands. It is cultivated for ornamental purposes in West Indies, Africa, North and South America, and Saudi Arabia. It was used in a hybridization programme at Jodhpur (Singh and Yadava 1984). It is probably a garden escape and has run wild in southern India.

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We are thankful to the Head, Department of Botany, Shivaji University, Kolhapur, for laboratory facilities. We are grateful to Dr. R.V. Gurav for encouragement and Mr. S.S. Kambale for valuable help. We also thank World Bank for financial assistance to National Agricultural Innovative Program (NAIP), Government of India, New Delhi, under which this work was completed.

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11. *SPIGELIA ANTHELMIA* L. (SPIGELIACEAE): NEW RECORD TO THE FLORA OF GUJARAT STATE, INDIA

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During a recent botanical excursion to South Gujarat, the authors noticed a plant on the Karjan river bank at Kolivada (21° 41.050' N; 73° 29.025' E; 168.85 m). Perusal of literature suggested that it belonged to the family Loganiaceae *sensu lato*. After critical observations of the flower and fruit, the species was identified as *Spigelia anthelmia* L., family Spigeliaceae Mart., which has been segregated from Loganiaceae *sensu strict* (Struwe *et al.* 1994;

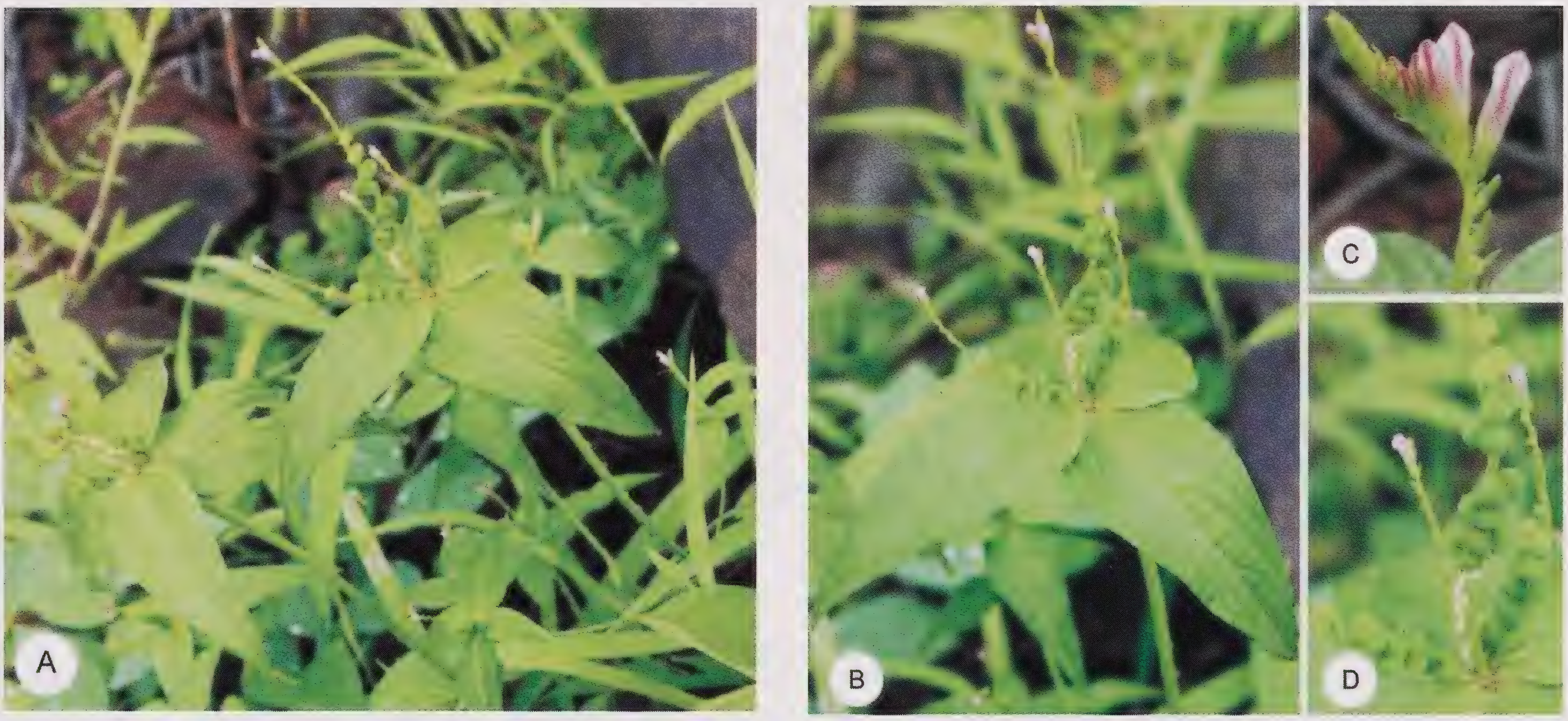

Fig. 1. *Spigelia anthelmia:* A. Habit; B. Close-up of inflorescence; C. Close-up of floral buds; D. Close-up of fruits

Watson and Dallwitz 1992). Morphologically, Spigeliaceae can be recognised by their opposite or whorled leaves, often in false whorls towards the stem tips, one-sided cymose inflorescences, often brightly coloured pentamerous flowers with usually funnel-shaped or tubular corollas, articulated styles, gynaecium eu-syncarpous, strongly bilobed capsules, capsule compressed contrary to the septum, circumscissile (the cupular base of the fruit remaining in the persistent calyx).

Spigelia L. is a neotropical genus of *c.* 60 species, distributed from South to Central America, Mexico, and the Caribbean, into the warm-temperate southern United States and tropical Asia to North Australia (Zappi 2005). High diversity of *Spigelia* has been reported from South America (Zappi *et al.* 2010). In India, *S. anthelmia* L. was first reported from Madhya Pradesh by Oomachan and Shrivastava (1987) around the forests of Jabalpur. Later, it was recorded from Tamil Nadu and Maharashtra (Kamble and Chaturvedi 2010; Pardeshi and Srinivasu 2006; Uma Maheswari *et al.* 2000). After perusal of literature (Cooke 1902–08; Shah 1978), the collected specimen was found to be new to the flora of Gujarat state.

Pradeepkumar (1994) and Pradeepkumar and Prathapasenan (2003) did not report the presence of *Spigelia anthelmia* from the Rajpipla, Dediapada, and Shoolpaneshwar Wildlife Sanctuary, but we recorded it during our recent visit to these sites. The first report of *S. anthelmia* was by Oomachan and Shrivastava (1987) from Jabalpur forest along the Narmada river in Madhya Pradesh. It was later reported from Nagpur by Kamble and Chaturvedi (2010). It appears that the species may have been introduced through rivers or road (via transport).

The details of the specimen collected are given below:

***Spigelia anthelmia* L.,** Sp. Pl. 149, 1753; *S. multispica* Steudel, Flora 26: 764, 1843.

Distribution: Karjan river bank at Kolivada (21° 41.050' N; 73° 29.025' E; 168.85 m), Shoolpaneshwar Wildlife Sanctuary, Dediapada Tehsil, Narmada District, Gujarat, India; BARO/RJD 933, 954.

Flowering and Fruiting: July–October.

Habitat: Moist places in the forest, near streams and river banks.

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12. *LUISIA TRICHORRHIZA* (HOOK.) BLUME – AN ADDITION TO THE ORCHID FLORA OF MAHARASHTRA, INDIA

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Introduction

During our field visits to the Vidarbha region of Maharashtra, an interesting epiphytic orchid was found, which was identified as *Luisia trichorrhiza* (Hook.) Blume. This species is a new record for the state, from which five species of the genus have been recorded earlier (Almeida 2009; Lakshminarasimhan 1996). The voucher specimens were deposited in the Herbarium of Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (BAMU), and below, we provide an account of the species.

Luisia trichorrhiza (Hook.) Blume Mus. Bot. 1: 63. 1849; Saxena and Bramham in Fl. Orissa 3: 1840. 1995. *Vanda trichorrhiza* Hook. Exot. Fl. 1(5): t. 72. 1825.

Erect stout herb. Roots with minute hairs. Stems stout, dark green in colour. Leaves 13–15 cm long, terete. Inflorescence 3–4 flowered, extra-axillary. Flowers 3–4 mm across, drooping. Bracts 1-nerved, scabrid. Sepals greenish-yellow, tinged with purple, entire, glabrous, 3-nerved; dorsal sepal slightly incurved at apex; lateral sepals keeled, acute at apex. Petals 3-nerved, 2 short nerves from the sides of lateral nerves, pale green. Lip panduriform in outline; hypochile subquadrate, concave, yellowish-green; epichile rhomboid, rounded at apex. Capsule narrowly spindle-shaped, tapering towards the base.

Flowering: July–August

Fruiting: Fruits mature up to the next season.

Notes: The species is an epiphyte on *Cleistanthus collinus* (Roxb.) Benth., *Madhuca longifolia* (Koen.) Mac. var. *latifolia* (Roxb.) Chevalier, *Mangifera indica* L., and *Terminalia elliptica* Willd. Very rare in distribution and found as single individuals in the habitat studied. It is often difficult to locate the species amidst the green foliage of trees.

Distribution: Amravati and Gadchiroli districts of Vidarbha, Maharashtra.

Specimens Examined: Amzari (21° 23' 0.001" N; 077° 6' 1.6" E) 25.xi.2011, *GD Muratkar 2433* (flowering) (BAMU) and 29.x.2012 *GD Muratkar 2433* (fruiting) (BAMU) in Amravati District; Bhamaragad range 2.x.2007 *RS Govekar 197* (fruiting) (BAMU), Murumgaon-Sawargaon Road 18.ii.2011 *RS Govekar 764* (fruiting) (BAMU) and Besewada hills of Gatta range, 26.v.2011 *RS Govekar 967* (flowering) (BAMU) of Gadchiroli district.

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13. *DIPCADI MONTANUM* (DALZELL) BAKER – AN ADDITION TO THE FLORA OF KERALA, INDIA

SOJAN JOSE[1,3,*], V. SURESH[1,4], R. PRAKASH KUMAR[2,5] AND P.V. MADHUSOODANAN[2,6]

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Introduction

The genus *Dipcadi* Medik. (Family: Hyacinthaceae) with about 30 species is distributed in the Mediterranean region, Africa, and south-west Asia (Mabberley 1997). The greatest diversity is found in South Africa, where about 13 species are present (Stedje and Nordal 1987). Medikus (1790) described the genus *Dipcadi* using *Hyacinthus serotinus* L. from Spain as the type species. Later, Ker-Gawler (1816) described another genus *Uropetalon* and he moved several species placed under *Dipcadi* to *Uropetalon*. Baker (1871) resurrected *Dipcadi* and treated *Uropetalon* as its synonym. In India, the genus was earlier represented by nine species, including four varieties (Deb and Dasgupta 1981; Karthikeyan *et al.* 1989). A new species was reported later by Prabhugaonkar *et al.* (2009).

Dipcadi was not reported from Kerala till we recorded the occurrence of *Dipcadi montanum* from a rocky area of Kollengode, Palakkad district, Kerala. The voucher specimens were deposited in the Calicut University Herbarium (CALI) and the herbarium of Malabar Botanical Garden (MBGS). In this manuscript, we provide a description of the species with notes.

***Dipcadi montanum* (Dalzell) Baker.** Baker in Journ. Linn. Soc. 11: 398. 1871; Hook.f. Fl. Brit. Ind.6: 346. 1892; Cook, Fl. Pres. Bomb., 2: 769. 1907; Bamber. Pl. Punj. 441. 1916; Deb and Das Gupta, *J. Bombay Nat. Hist. Soc. 75*: 57. 1976.

Scapigerous herb with small globose tunicate bulbs, 12–20 x 10–15 mm; Leaves 3–8, shorter than the scape, 15–20 x 0.2 cm, narrowly linear, glabrous, acuminate at the apex; Scapes 15–30 cm x 2–3 mm, subterete, smooth, glabrous, erect, stiff; Inflorescence 5–15 cm long, 7–15 flowered racemes; Bracts small 5–8 mm; Flowers mildly fragrant, white with various degrees of red tinge, 11–13 mm long, small; pedicels 3–8 mm long, filiform; Perianth tubular, cylindric with six segments united up to 1/3rd of the length, the outer recurved from the middle and inner bent at the tip. Stamens 6, inserted in the throat of perianth, included; filaments adherent to the perianth tube except at the tip. Anthers 2–3 mm, linear-oblong, versatile, introrse. Ovary stipitate, 3-celled with many ovules; Style short and straight; Stigma 3-lobed. Fruit broader than long, narrowed at the base, 5–10 x 10–15 mm, deeply trilobed; Seeds 3–5 in each locule, compressed, 3.5–5 x 3–4 mm orbicular, wrinkled, brownish-black.

Flowering and Fruiting: July to September.

Distribution: INDIA: Karnataka, Tamil Nadu, Maharashtra, Odisha, Madhya Pradesh, Chhattisgarh, and rarely in the western Himalaya.

Specimens Examined: INDIA: Kerala, Palakkad district, Kollengode (10° 34' 31.18" N; 76° 42' 48.92" E; 108 m above msl), 12.viii.2012 Sojan and Suresh 9200 (MBGS).

Notes: An erect, seasonal herb that grows on rocky slopes. Usually found in groups of various sizes. The typical associates were *Rhamphicarpa longiflora*, *Centranthera indica*, *Chamaecrista kleinii*, *Indigofera uniflora*, and *Parasopubia delphiniifolia*.

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14. ABSENCE OF *ULVA RETICULATA* FORSSKAL FROM THE COAST OF GOA, INDIA

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Ulva reticulata Forsskal was first reported by Boergesen (1935) from Mumbai in Maharashtra, followed by Krishnamurthy and Joshi (1969) from Diu in Gujarat. Later, Dhargalkar (1978) reported it from the Chapora Bay in Goa. The growth of *U. reticulata* was found to be optimum during periods of high salinity from December to May and would diminish during the monsoon. This particular species of *Ulva* is known to favour polychaete tubes as its substratum, and its growth was found to correspond with sewage discharge (Dhargalkar 1978). Reticulate form of thallus and the presence of air bladders make this species unique among the species of genus *Ulva*.

In earlier studies, at Chapora Bay, this taxon was found to occur with edible bivalves such as *Meretrix casta*. Though the rocky substrate exhibited growth of oysters and green mussels, surveys by us during October 2008–December 2010 did not reveal the presence of *U. reticulata* in the Bay. The absence of this species points towards probable ecological changes that could have occurred in more than last two decades. The surveys revealed the presence of several algae, barring this mesh-forming alga. Increased sedimentation resulting from sand-mining activities in Chapora river may have led to the depletion of polychaete tubes from the area, resulting in the wiping out of this species.

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CONTENTS

EDITORIAL 171

THE BIRDS OF SANGLI DISTRICT, MAHARASHTRA, INDIA
V.B. Tuljapurkar, V.R. Bhagwat and G.A. Jathar 172

NOTES ON THE NEWLY DISCOVERED POPULATION OF SIND JERDON'S BABBLER *CHRYSOMMA ALTIROSTRE SCINDICUM* IN HARIKE WILDLIFE SANCTUARY, PUNJAB, INDIA
Saurabh Sawant and M. Sudhagar (IFS) 187

A PRELIMINARY OVERVIEW OF THE SUBSPECIES OF RED FOX AND TIBETAN SAND FOX IN THE HIMALAYA, INDIA
Aishwarya Maheshwari, Neha Midha, Ambica Paliwal, Basant Kumar Sharma, Partha Sarathi Ghose, Priyadarshinee Shreshtha and Srushti Paranjpe 193

DORYLAIMID AND TYLENCHID NEMATODES ASSOCIATED WITH BANANA PLANTATIONS IN PASCHIM MEDINIPUR DISTRICT, WEST BENGAL, INDIA
Viswa Venkat Gantait, Amalendu Chatterjee and Tanmay Bhattacharya 197

SIGNIFICANCE OF PHALLIC COMPLEX IN THE CLASSIFICATION OF INDIAN PYRGOMORPHIDAE (ORTHOPTERA: PYRGOMORPHOIDEA)
Hirdesh Kumar, Mohd. Kamil Usmani, Uzma Rafi and Reenu Kumari 204

THE TRADE, TRAPPING, AND UTILIZATION OF LORISES IN INDIA
Abrar Ahmed 210

OBITUARY 214

REVIEWS 216

MISCELLANEOUS NOTES 220

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VOLUME 111(1): APRIL 2014

CONTENTS

EDITORIAL 1

ROLE OF MOTHER AND ALLOMOTHERS IN INFANT INDEPENDENCE IN CAPPED LANGUR *TRACHYPITHECUS PILEATUS*
Awadhesh Kumar and G.S. Solanki 3

FORAGING BEHAVIOUR OF THE NEAR THREATENED GREY-HEADED BULBUL *PYCNONOTUS PRIOCEPHALUS* IN RELATION TO SEASONS AND BREEDING STAGES
P. Balakrishnan 10

THYSANOPTERA (INSECTA) FAUNA OF THE KEIBUL LAMJAO NATIONAL PARK, MANIPUR, NORTHEAST INDIA
K. Nishikanta Singh and R. Varatharajan 19

AEROBIC CULTURABLE BACTERIAL MICROFLORA IN RESIDENT *GYPS* VULTURE SPECIES OF INDIA
Rohan N. Shringarpure, Mandar D. Kulkarni, Chhaya Sawant, Ashok Bhagwat, Toby H. Galligan and Vibhu Prakash 29

OBITUARY

T.C. NARENDRAN (1944–2013) 36

REVIEWS

1. INDIAN MAMMALS – A FIELD GUIDE
Reviewed by Anwaruddin Choudhury 38

2. BIRDS AND PEOPLE
Reviewed by Gayatri W. Ugra 39

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MISCELLANEOUS NOTES

MAMMALS

1. Dietary opportunism in Desert Fox or White-footed Fox *Vulpes vulpes pusilla*
Harkirat Singh Sangha 40

2. Ferret-Badger records from Mizoram, Meghalaya, and Nagaland, India
Nimesh Ved and Laltlanhlua Zathang 41

3. On the occurrence of dark-coloured Indian or Red Muntjac *Muntiacus muntjak* Zimmermann in Sikkim-Darjeeling areas with a recent sighting from west Sikkim, India
Anwaruddin Choudhury 43

AVES

4. Sighting of the Red-billed Tropicbird *Phaethon aethereus* from Gopalpur-on-sea, Odisha, India
Avisek Chatterjee and Dipabali Paul 44

5. Grey-faced Buzzard *Butastur indicus*: first record from India
Shirish Manchi, Asad R. Rahmani and Dhritiman Mukherjee 45

6. First record of Pectoral Sandpiper *Calidris melanotos* and Caspian Plover *Charadrius asiaticus* from Kerala, India
P.C. Rajeevan, K.M. Khaleel and Jayan Thomas 45

7. First record of Red-necked Phalarope *Phalaropus lobatus* from Kerala, India
Muhamed Jafer Palot, Dipu Karuthedathu, Praveen J., Mike Prince and E. Kunhikrishnan 46

8. Oriental Skylark *Alauda gulgula* nesting in Elephant dung in Corbett Tiger Reserve, India
Manoj Sharma 47

REPTILES

9. Capturing problem Saltwater Crocodiles *Crocodylus porosus* Schneider using indigenous techniques in the Andaman Islands, India
Viswakannan, P., C. Sivaperuman, S. Senthil Kumar and Shashikumar 48

10. Record of the rare Bibron's Coral Snake *Calliophis bibroni* from Nelliyampathy hills, Kerala, India
Jospeh J. Erinjery, Sayantan Das, Ram Subramanian Muthuvarmadam and Mewa Singh 51

FISH

11. *Apogon hyalosoma* Bleeker (Pisces: Percoidei: Apogonidae) – a new report to Kerala, India
M.H. Shyla and K.S. Jameela Beevi 52

12. First report of three Surgeon fishes (Family: Acanthuridae) from the north of east coast of India
Dipanjan Ray, Prasad C. Tudu and Anil Mohapatra 54

13. On an abnormal specimen of *Lutjanus johnii* (Bloch, 1792) (Pisces: Perciformes: Lutjanidae) from West Bengal coast, India
R.P. Barman, A. Das and S.S. Mishra 57

INSECTS

14. New record of Lesser Blue Wing *Rhyothemis triangularis* Kirby, 1889 (Odonata: Libellulidae) from Odisha, India
S.K. Sajan and Pratyush P. Mohapatra 60

15. Species diversity of butterflies (Insecta: Lepidoptera: Rhopalocera) on two trees of south Andaman, India
T.C. Khatri 61

OTHER INVERTEBRATES

16. A note on the occurrence of *Sternaspis scutata* (Renier 1807) – a sternaspid polychaete from Sundarban mangroves, West Bengal, India
H.M. Preetha Mini Jose, S. Muthuvelu, S. Sivaraj and P. Murugesan 62

BOTANY

17. *Plagiochila duthiana* Steph. – a poorly known species discovered from Western Ghats, India
Praveen Kumar Verma and Krishna Kumar Rawat 64

18. *Begonia integrifolia* Dalzell – an addition to the flora of Goa, India
Makarand M. Aitawade and Shrirang R. Yadav 66

19. *Artemisia santolinifolia* Turcz. ex Besser (Asteraceae) – an overlooked species in Indian flora
Bhaskar Datt, Meena Baleshwar and T.S. Rana 67

20. *Physalis pruinosa* L. (Solanaceae) – a new record for the flora of Uttar Pradesh and Uttarakhand, India
S.C. Singh and Bhaskar Datt 69

Cover Photograph: Sambar *Rusa unicolor* By Aditya Singh

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Editorial

Unique amphibians of the Western Ghats: a plea for their protection

The Western Ghats is one of the 25 biodiversity hotspots of the world, due to which it was given World Heritage status recently. Richness of species and endemicity at family, genus, or species level is typical of the biodiversity of this region. For example, in India there are reports of about 335 species of amphibians and 520 species of reptiles, of which about 200 amphibian and 120 reptile species are endemic or confined to the Western Ghats. In the last decade, around 100 new species of amphibians and reptiles have been described from the Western Ghats (Abraham *et al*. 2013; Biju and Bossuyt 2003; Biju *et al*. 2011; Nair *et al*. 2012; Vijayakumar *et al.* 2014). The formidably named *Nasikabatrachus sahyadrensis* is one such example, described in 2003 by India's well-known amphibian expert Dr. S.D. Biju. Its English name is Pig-nosed Frog due to its protruding nose. Interestingly, the tadpole was described nearly 100 years ago, but no one had seen the adult which generally lives under soft mud and appears only during the monsoon for mating. As the tadpoles live in torrential streams, they have developed suckers, much like hill-stream fishes. It is found on both sides of the Palghat Gap in Kerala near forest streams and rivers.

The smallest known amphibian in the Western Ghats is *Nyctibatrachus minimus* at a mere 15 mm length. The largest is the Indian Bull Frog *Hoplobatrachus tigerinus*, which is sometimes seen feeding on small snakes. The other important groups of amphibians which are limbless and predominantly burrowing are called caecilians. Of the 39 known species of caecilians in India, about 25 species are endemic to the Western Ghats. The smallest among them is *Gegeneophis krishni* (200 mm) and longest is *Ichthyophis bombayensis* (640 mm).

As of now, ten genera of Anurans are known to be endemic to the Western Ghats. The genus *Indirana* is one of them, with 11 species, including the newly-described *Indirana chiravasi* (Padhye *et al*. 2014) from the northern Western Ghats, which the authors named Amboli Leaping Frog. According to the IUCN (2014), two species of this genus are Critically Endangered, three are Endangered, one is Vulnerable, two are Data Deficient, and two are Least Concern. The true status of Amboli Leaping Frog needs to be studied through extensive surveys of its habitat.

Pollution, over-extraction of natural resources, invasive species, infrastructural developments particularly dams, habitat fragmentation, agricultural expansion, and lack of appreciation of the ecological role of amphibians (and other taxa) are some of the reasons for their decline. On top of this, amphibians are dying of infections and diseases (Dahanukar *et al*. 2013; Stuart *et al*. 2004). Climate change is another long-term threat that will alter their fragile habits and allow spread of diseases in new places.

With a population of 400 million people, the Western Ghats is no doubt one of the most populated biodiversity hotspots of the world. Biodiversity Hotspot is described as an area rich in biodiversity but also under a high degree of threat. In view of the ecological significance of the Western Ghats and increasing threats, as well as possible impacts of climate change, the Ministry of Environment, Forests and Climate Change, Government of India, in March 2010, constituted a Western Ghats Ecology Expert Panel (WGEEP), led by Prof. Madhav Gadgil. The expert panel submitted their report on August 31, 2011, which was debated and finally rejected by the Government of India. The WGEEP had suggested that the entire Western Ghats be treated as Ecological Sensitive Area (ESA) which the government was not willing to do. To water down the report, the government set up a High Level Working Group on Western Ghats under the chairmanship of Mr. K. Kasturirangan. The Committee came up with its own recommendations, diluting many recomendations of the WGEEP. It is beyond the scope of this editorial

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to discuss the merits and demerits of these two reports. I would like to bring to the readers' attention that WGEEP used a new term Ecologically Sensitive Localities (ESL) that was mainly identified by civil society. This was to distinguish it from the term Ecological Sensitive Area (ESA) that they have used for the whole Western Ghats. While it will not be possible to give details of these ESLs, many of them are important for conservation of amphibians and other taxa.

In order to identify sites for short and long term conservation of birds and their habitats, BirdLife International, UK, came up with the concept of Important Bird Area. The IBA concept has been well-tested and now accepted the world over, resulting in identification and protection of nearly 12,000 IBAs in the world. The concept has recently been expanded to include biodiversity other than birds, therefore now the full form of IBA is Important Bird and Biodiversity Area. The BNHS, being BirdLife Partner in India, has a major IBA Programme. Ten years ago, we brought out an IBA inventory called *Important Bird Areas in India*: *Priority Sites for Conservation* (Islam and Rahmani 2004). This inventory is being revised and by the end of this year (2014) we will bring out a revised and updated edition in which non-bird taxa, particularly amphibians and reptiles, will be highlighted wherever necessary. The Western Ghats also has many endemic and threatened fish species that need to be protected. Several genera such as *Travancoria*, *Dayella*, *Horabagrus*, and *Lepidopygopsis* are restricted to the Western Ghats. A few species are restricted to the west flowing rivers, and others to east flowing rivers. We need to identify and protect rivers and streams where the endemic fish gene pool survives. Many of these rivers are outside the present Protected Area Network of India. Dams, pollution, overharvesting, and invasive species have already devastated the neglected fish fauna of the Western Ghats.

The IUCN has come up with its own concept of Key Biodiversity Areas (KBAs). Many botanists have come up with the idea of identifying Important Plant Areas (IPAs), and WWF-India is working on the landscape level. Perhaps all these concepts can be brought together for identification and protection of areas that are really important for the survival of all types of taxa, and not only mega-vertebrates which have hogged the limelight all these years in India. Although larger landscape level protection is beneficial to keep meta-populations and allow gene flow, it is always not possible to have large landscape level protected areas. Focusing conservation action on key areas is one of the most effective means to reduce biodiversity loss.

Asad R. Rahmani

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ROLE OF MOTHER AND ALLOMOTHERS IN INFANT INDEPENDENCE IN CAPPED LANGUR *TRACHYPITHECUS PILEATUS*

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We investigated the mother-infant relationship and allomothering in Capped Langur *Trachypithecus pileatus* in Pakhui Wildlife Sanctuary, Arunachal Pradesh, India, from July 2001 to June 2003, based on observations of five mother-infant pairs. Infants spent 75% of the time on ventro-ventral contact during the first three months, 71% of which was on nipples in the first month, which decreased gradually thereafter. The time of contact with mother varied significantly ($p< 0.01$) across the months. A significant negative correlation (Pearson: $r = -0.963$, $p <0.01$) was found between the time infants spent with mother with increase in age (n=5 mother-infant pairs; 60 observations). Infants started straying away from mothers at around 16 days of age, and moved away as far as 3 m at the age of 30 days. The distance away from the mother increased up to 5 m at the age of 3 months, and they spent about 20% of their time away from the mother at the age of a year. Neonates spent 9.2% of the day with allomothers, and this increased to 25% for the next 15 days. It decreased gradually from the second month, and allomothering was not observed from the eighth month. The process of infant's independence started at the age of 6–8 months and was completed by 12 months, with infants spending 80% of their time away from the mother.

Key words: Allomothering, Capped Langur, mother-infant relationship, maternal rejections, ventro-ventral contact

INTRODUCTION

Primate infants are born dependent on their mothers (Strier 2007) and mothers play a significant role throughout the offsprings' lives (Hrdy 1999). The mother-infant relationship and parental care has special significance in mammals because it ensures the survival of infants and sets the stage for relations among the members of the troop. A long period of postnatal development is a characteristic feature of primates. Newborns depend on their mothers for nutrition, transport, protection, and mothers also help them to develop skills to become independent and integrate within the society (Förster and Cords 2002; Harlow and Harlow 1965; Hinde and Spencer-Booth 1967; Jensen *et al*. 1967; Xi *et al*. 2008).

The other important aspect of social behaviour in colobines is an affiliation between allomothers and infants (Horwich and Manski 1975; Jay 1963; Kumar *et al*. 2005; McKenna 1979, 1981; Stanford 1992; Vogel 1984). The relationship of mothers and allomothers with infants in the group leads to the growth and development of an infant in a socially coordinated manner (Kumar *et al*. 2005). It has been argued that allomothers provide assistance to the mother so that she can have time for foraging (Stanford 1992; Vogel 1984; Xi *et al*. 2008); infants learn to manage in the absence of their mothers, which ensures proper socialization with others members of the troop (McKenna 1981); and immature females of the troop also get an opportunity to handle infants (Hrdy 1976; Lancaster 1971). The mother may derive benefits from the allomothers' cooperation in territorial defence, in anti-predation, and save on time and energy that can be devoted for infant care (Garber *et al*. 1984; Koenig and Rothe 1991). Allomothering thus increases the chances of the infant's survival. The development of mother-infant relationship in nonhuman primates also influences the ontogeny of social behaviour (Nicolson 1987).

Studies on mother-infant relations and infant development in captive and free-ranging Old World monkeys have concentrated mainly on *Macaca mulatta* (Berman 1980a, b, 1990, 1992; Berman and Kapsalis 1999; Maestripieri 1994a, b, 2001; Simpson 1985; Stevenson-Hinde and Simpson 1981), *M. silenus* (Krishna *et al*. 2008), *M. radiata* (Singh *et al*. 1980) and *M. fuscata* (Schino *et al*. 1993, 1995, 2003; Schino and Troisi 2001). Other primate species studied are *Papio* spp. (Altmann 1980; Nash 1978), *Cercopithecus aethiops* (Fairbanks and McGuire 1985; Lee 1984; Struhsaker 1971), *C. mitis stuhlmanni* (Förster and Cords 2002), *Cercopithecus neglectus* (Kirkevold and Crockett 1987), *Presbytis entellus* (Dolhinow and Murphy 1982), *Cebus capucinus* (Manson 1999), and *Callimico goeldii* (Schradin and Anzenberger 2001). Studies on mother-infant relationships and behaviour development of infants are scarce on colobine monkeys (Horwich 1974a, b; Horwich and Manski 1975; Jay 1963; Medhi 2004; Sugiyama 1965). To help fill in this lacuna, we undertook a study on the mother-infant relationship and allomothering in the Capped Langur in Pakhui Wildlife Sanctuary, Arunachal Pradesh, India.

The Capped Langur *Trachypithecus pileatus* is restricted to Northeast India, Bangladesh, north-western Myanmar, Bhutan, and southern China (Ahsan 1994; Khan and Ahsan 1986; Roonwal and Mohnot 1977; Srivastava 1999; Zhang *et al.* 1981). It is largely folivorous and a canopy dweller (Choudhury 1989; Stanford 1991), lives in a troop of 5–8 individuals, mainly with one-male multi-females composition. The Capped Langur is designated an endangered species in India (Walker and Molur 2007) because the population and troop size are becoming smaller due to fragmentation and loss of habitat, and use of its flesh and body parts in traditional healthcare and socio-cultural practices (Kumar and Solanki 2004). The Capped Langur falls under the Vulnerable category (A2cd+3cd, ver 3.1) as per IUCN (2013) Red List.

MATERIAL AND METHODS

Study Site

Pakhui Wildlife Sanctuary (26° 3.7′–27° 16.2′ N; 92° 7.5′–92° 22′ E; 862 sq. km) is located in East Kameng district of Arunachal Pradesh. The Sanctuary is surrounded by rivers on three sides, namely Kameng in the north and west, and Pakke in the east, and shares a common boundary with Nameri National Park, Assam. It receives an average annual rainfall of 2,545 mm. The annual mean maximum temperature is 31° C, and the mean minimum temperature is 18° C. Average relative humidity is 84%. The altitudinal variation ranges from 100 m to 2,040 m above sea level (Solanki *et al.* 2008). The Sanctuary harbours different vegetation types, namely tropical evergreen forest, tropical semi-evergreen forest, and subtropical forests (Champion and Seth 1968). A total of 234 woody species of flowering plants (angiosperms) have been recorded from the lowland areas of the Sanctuary.

Several rare and endangered species of fauna inhabit the Sanctuary. There are four species of primates: *Macaca mulatta, M. assamensis*, *Trachypithecus pileatus*, and *Nycticebus bengalensis*. The ungulates comprise Gaur *Bos frontalis*, Barking Deer *Muntiacus muntjak*, Sambar *Cervus unicolor*, Goral *Naemorhedus goral*, Wild Goat *Capricornus sumatraensis*, and Wild Pig *Sus scrofa*. The Asian Elephant *Elephas maximus* and Tiger *Panthera tigris* also occur. The Sanctuary is also rich in avifauna with 257 bird species, including four species of hornbills (Datta *et al.* 1998; Singh 1991, 1994).

Study Animals

Two well-habituated troops of Capped Langur (HP1 and HP2) were observed for a period of two years (July 2001 to June 2003). Initially, group HP1 comprised eight individuals (1 adult male, 5 adult females, 1 subadult female and 1 infant) and HP2 comprised seven individuals (2 adult males, 4 adult females and 1 juvenile). Five infants (2 females and 3 males) were born between December 2001 and March 2002 in these troops. All the five infants were selected and observed for 12 months to understand their social interactions and activity patterns with their mothers and allomothers in the troop. Each mother and her infant were identified on the basis of facial, physical and other features like the shape of the tail hairs. A summary of the age and sex of the selected infants is provided in Table 1.

Table 1: Name of infant/mother, and sex and date of birth of infant

Infant's name / Mother's name	Sex of infant	Date of Birth
HP1-I / HP1A	Female	23.12.2001*
HP1-II / HP1B	Female	02.02.2002 (- 2days)**
HP1-III / HP1C	Male	05.03.2002 (- 4days)**
HP2-I / HP2A	Male	18.01.2002 (- 5days)**
HP2-II / HP2B	Male	11.02.2002*

*Birth observed; **Estimated birth date – based on sighting date of newborn.

Table 2: Types of interaction recorded between mother and infant, and infant and allomothers

	Interaction categories		Description
1.	Time in mother's contact	:	Time an infant spent in ventro-ventral or in any other type of body contact (including nipple contact).
2.	Time off <3 m away from mother	:	Time that infant remains within 3 m of the mother.
3.	Time off >3 m away from mother	:	Time that infant remains more than 3 m away from the mother.
4.	Maternal restriction	:	Number of times/hour the mother restrained the infant from moving away, or pulled the infant back after it strayed.
5.	Maternal rejection	:	Number of times/hour the mother pushed the infant away from her or denied nipple access.
6.	Allomothering	:	Infants being taken care of by non-mother females

Data collection and analysis

The observations were recorded by the first author with binoculars from a distance of 10–30 m. The data on mother-infant relationships and allomothering were collected through focal sampling with a 5-min sampling interval (Altmann 1974) for all the five mother-infant pairs for 12 months from the birth of the infants. Total 660 scans were collected for the selected pairs per month.

Instantaneous recording included noting the number of times the mother prevented her infant from moving away, and rejecting the infant when it tried to access her nipples (Martin and Bateson 1993). At each sampling interval, we recorded 6 types of behavioural interactions between the mother and infant, and infant and allomothers (Table 2). These behavioural interactions are well-described by Horwich and Manski (1975), Berman (1980a), Förster and Cords (2002), and Schino *et al.* (2003).

RESULTS

Pattern of infant-mother contact

Infants (*n*=5) spent about 75% of their time in contact with the mother during the first three months (Fig. 1). Subsequently, contact time with the mother decreased gradually with increase in age. When infants were 12 months old, the average time spent with the mother was 18% (±3.1). A significant negative correlation (Pearson: r = -0.963, $p < 0.01$) was found between the time infants spent with mother with increase in age (*n*=5 mother-infant pair; 60 observations). On the 16th day, infants started straying away from their mothers. When about 30 days old, infants spent about 3% of their active time straying (< 3 m) away from mothers. This distance increased with the age, with the distance strayed away from the mother increasing to 5 m at the age of 3 months. The incidences of straying for the < 3 m and > 3 m distance categories analysed showed an increase with the months (Fig. 2), which were statistically significantly (t test; t=2.3; $p<0.05$). Infants, by the age of 12 months, spent about 32% of their active time away from mothers.

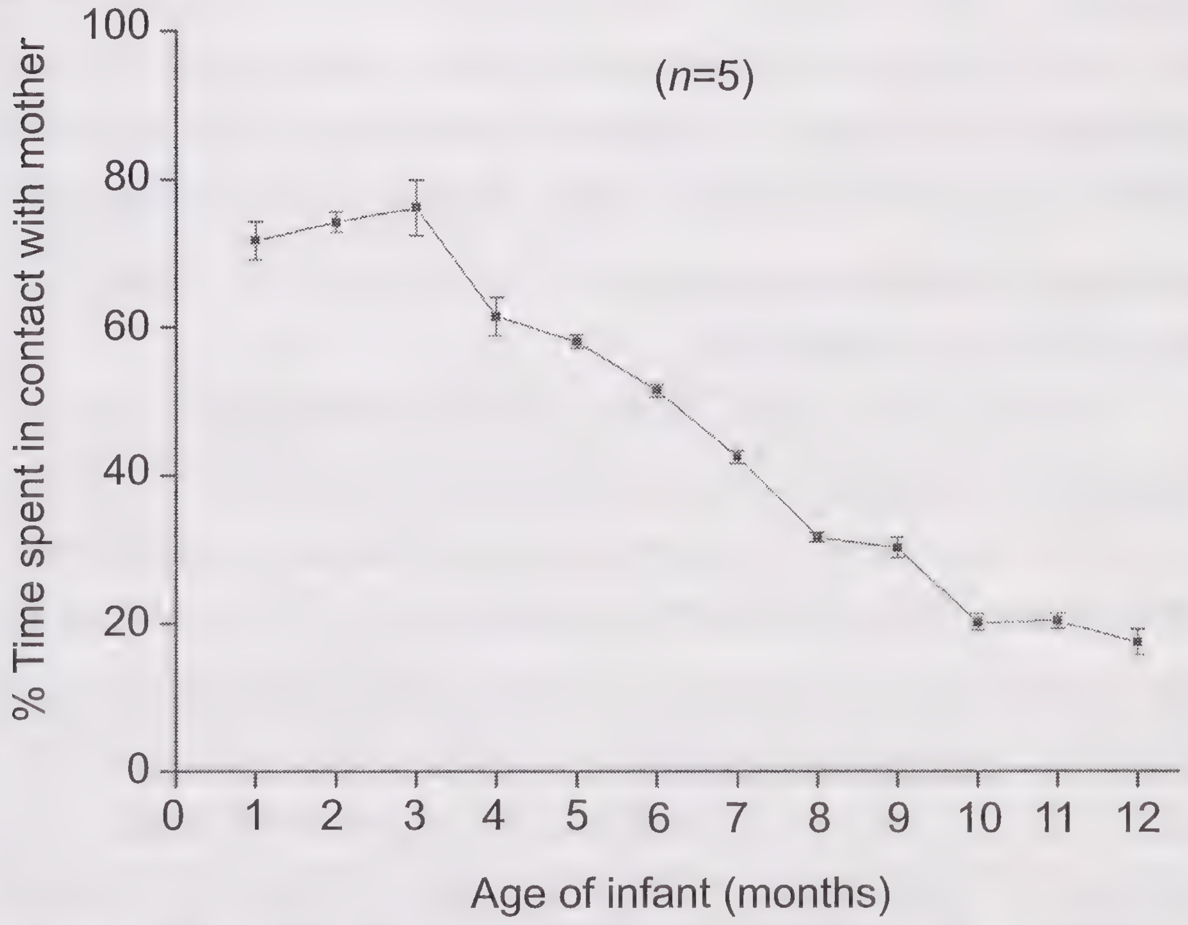

Fig. 1: Time infants spent (%) in contact with mother with age

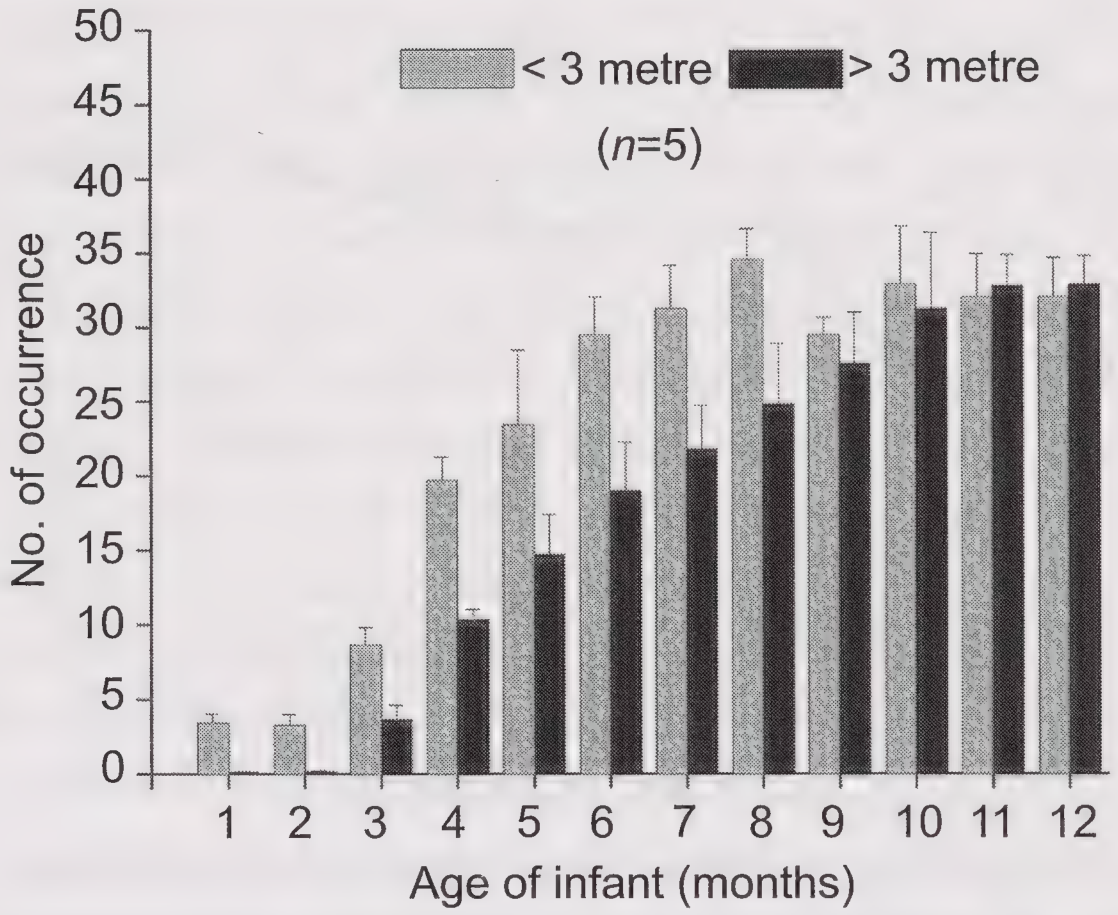

Fig. 2: Distances infants strayed away from mothers with age

Maternal restrictions and rejections

Mothers restricted the movements of infants in their early stages of life. Such restrictions were observed on 22 occasions, when infants were a month old. These restrictions reduced gradually with age, and mothers hardly restricted the infants when they were about six months old (Fig. 3).

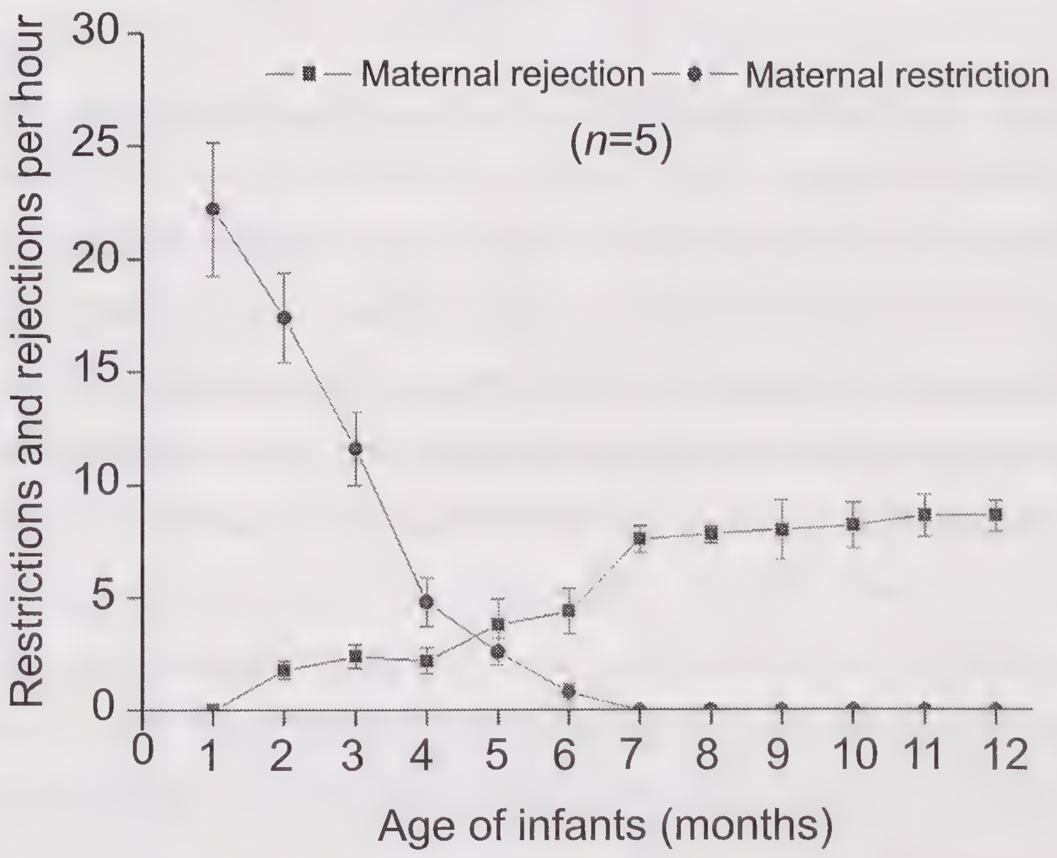

Fig. 3: Maternal restriction and rejections with age of infant

Mothers also discouraged infants' access to their nipples with age. The rejections started at the age of 2 months, and gradually reached around 7.4 (± 1.3) rejections/hour at 9 months of age. Thereafter, rejections were stable at between 8.8–9.2 rejections/hour until 12 months of age (Fig. 3).

Allomothering

We observed two live parturitions during the study, and allomothering was observed three hours after these births.

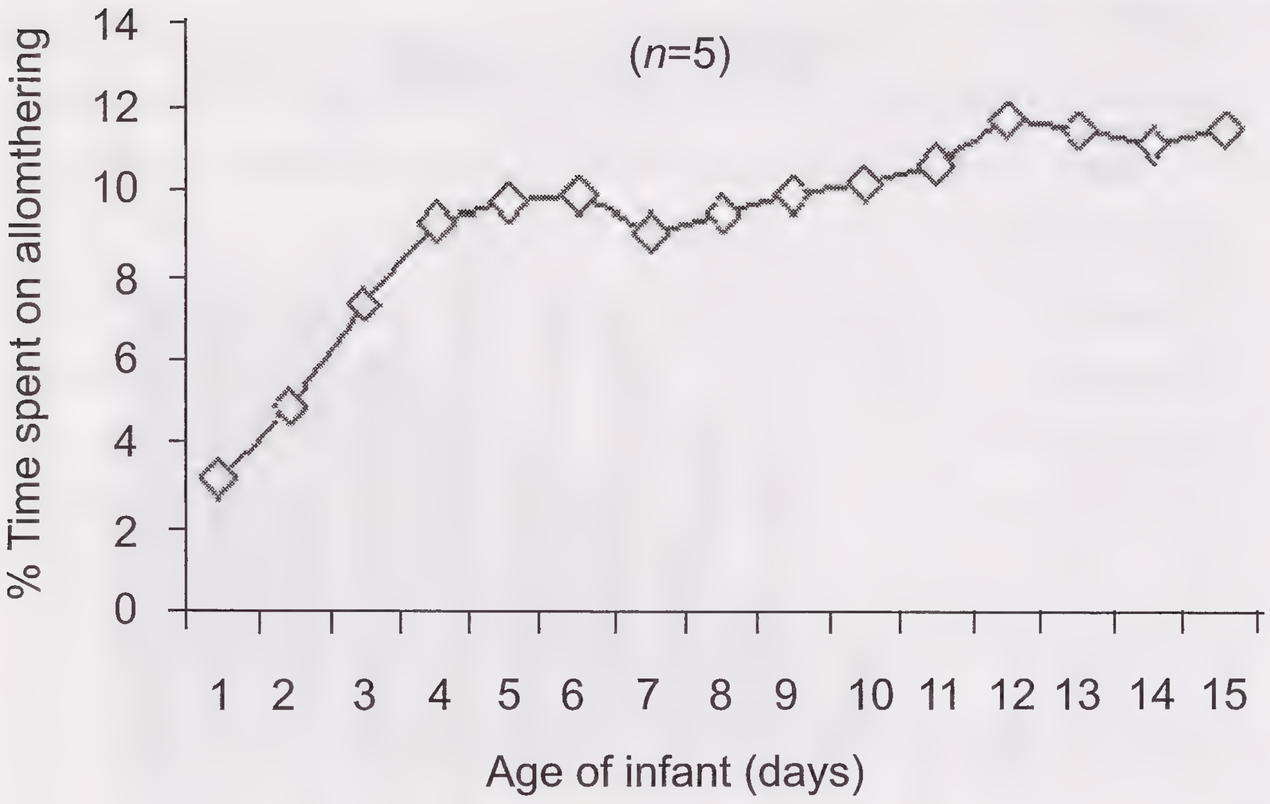

Fig. 4: Mean time spent (%) /day by neonates with allomothers

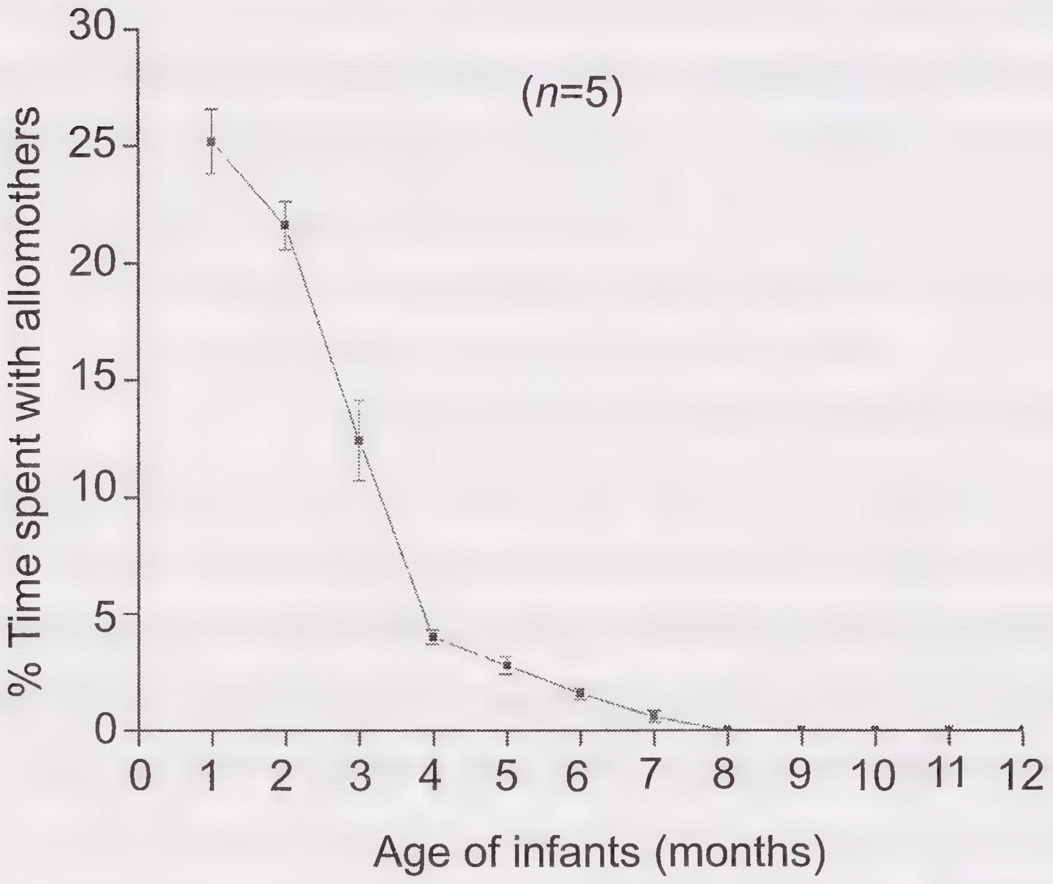

Fig. 5: Mean time spent (%) /month by infants with allomothers

Neonates were tended by three allomothers (individually) for an average of 9.2% (*n*=2) of the day during the first 15 days, and allomothering increased gradually till 15 days (Fig. 4). Considering the data on all five infants, it was found that the average time infants spent with allomothers constituted one-fourth of the daylight hours (25.34 ±2.84 %) during the first month (Fig. 5). After this, the association with allomothers decreased gradually, constituting about 5% in the fourth month, and was observed only on rare occasions in the seventh month; allomothering was not recorded in the eighth month (Fig. 5).

DISCUSSION

The early relationship between infants and their mothers is determined through the mothering style that varies among the individuals within a group, and also with different primate species. The difference is derived from the mother's prior experience in rearing infants and her rank in the group (Förster and Cords 2002). In this study on Capped Langur, maternal attachment and protection lasted about three months, and during this period, infants spent 75% of their time in ventro-ventral contact. During this period, the mother kept her newborn in close physical contact and never refused the infant's demands for contact and access to her nipples, and frequently restrained the attempted movements of the infant away from her during the first two months. Wild primate mothers carry their neonate wherever they move individually or in a social troop (Simonds 1974), barring members of Strepsirrhini. The neonate is generally too weak and physically uncoordinated in holding the mother when she walks. Therefore, the mother either holds it on her lap while sitting, or clinches it to her belly when she moves. In the Capped Langur, the mother holds the neonate in a ventro-ventral position with one forelimb and walks on three limbs during the 10 initial days after parturition (Kumar *et al.* 2005). To move between trees separated by some distance, the mother comes down to the ground instead of jumping.

Hinde and Atkinson (1970), Hinde and Spencer-Booth (1967), and Berman (1980b) related the degree of independence of the infant with the duration an infant remains away from the mother. We observed a similar trend with the degree of independence being related to the time spent away from the mother, and also by the distance kept away from her with age. Zothansiama (2013) also reported on the variations in distances kept away from the mother with age in captive Stump-tailed Macaque *Macaca arctoides* in India. The independence of an infant is controlled by the mother's behaviour to seek contact and proximity with the infant (Berman 1980a). With increase in age of the infant, the mother actively participates in developing independence in her infant by rejecting its attempts to contact her. In our study, Capped Langur mothers were recorded to reject the infants' demand for contact nine times in an hour at the age of 12 months, and they took a progressively smaller role in maintaining proximity and contact. The restrictions on moving away were more stringent in the early stage of the infant. Förster and Cords (2002) also recorded a similar pattern of maternal restriction in Blue Monkey. Thus, the mother ensures safety and also provides an opportunity to the infant to learn about the natural environment.

Kumar *et al.* (2005) observed live parturition in Capped Langur and recorded frequent allomothering of newborn that was of a few minutes duration only. However, Fairbanks (1989) and Berman (1990) indicated that mothers were less possessive and protective, and allowed allomothers to hold older infants longer than smaller ones. The mother's role in the infant's independence is often measured by the number of rejections an infant receives from the mother at the time of suckling (Altmann 1980; Förster and Cords

2002; Maestripieri 1995). Maternal rejections in our study were observed from the second month of the infant, and the frequency of rejections increased with the age of the infant, which is similar to Rhesus Macaque *Macaca mulatta* (Berman 1980a, 1990) and Blue Monkey *Cercopithecus mitis* (Förster and Cords 2002). In Bonnet Macaque *Macaca radiata*, the frequency of nipple contact drops by 50% after the second week of birth and the process for environment exploration begins at this stage, which gets completed at 12–15 months (Singh *et al*. 1980). However, in Lion-tailed Macaque *Macaca silenus*, there is sudden increase in nipple contact till the age of five and a half months; thereafter, there is a sharp decline in infants making nipple contact (Krishna *et al*. 2008).

Allomothering or infant transfer among the females of a troop is a prominent feature of several colobine species (Agoramoorthy 1991; Bernstein 1968; Hill 1972; Hrdy 1976; Jay 1962, 1963; Kumar *et al*. 2005; Prakash 1961; Poirier 1968; Quiatt 1979; Riedman 1982; Sugiyama 1965, 1967; Tanaka 1965; Wooldridge 1969), and allomothering is more common in colobine species than in Cercopithecines (Newton and Dunbar 1994). In the Capped Langur, maternal ambivalence phenomenon was observed on the first day of infant's life, just after three hours of postpartum (Kumar *et al*. 2005). Studies on several colobine species, including *Presbytis entellus* (Dolhinow 1982; Scollay and DeBold 1980; Sugiyama 1965; McKenna 1981), *P. johnii* (Poirier 1968), *P. pileata* (Stanford 1992), and *Colobus guereza* (Horwich and Manski 1975) have shown maximum allomothering occurring in the first month of the infant's age. We found it to be frequent (25%) in the Capped Langur in the first few months, gradually declining, and allomothering was not observed after the sixth month. Allomothering in the youngest stage does not occur normally among Cercopithecines, and newborn infants are only allowed to be touched or groomed by other members of the troop in later stages of life (Lancaster 1971; Rowell *et al*. 1964; Sugiyama 1965), but in Capped Langur, other members of the troop are also allowed contact with infants immediately after birth (Kumar *et al*. 2005). Capped Langur allomothers frequently interact with infants when they are with their mothers, the mothers passing on their infants mostly to adult females and occasionally sub-adult females of the troop. Infant handling by allomothers is primarily decided by the mother of the infant. Capped Langur mothers rarely attempted to retrieve infants from allomothers, which helps socialization in the infant. It appears that in this way, mothers try to cultivate a sense of independence in the infants. The mother's reinforcement behaviour is noticed in the form of rejection of nipple contact and relaxing restrictions on the infant's movement away from her, making the infant independent at the age of 6–8 months. At 12 months, infants remain 80% of time away from mothers and move away up to five metres, and spend 20% of the time with mothers. Thus, infants build their confidence by being independent in the natural environment, and can explore it for better survival.

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FORAGING BEHAVIOUR OF THE NEAR THREATENED GREY-HEADED BULBUL *PYCNONOTUS PRIOCEPHALUS* IN RELATION TO SEASONS AND BREEDING STAGES

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I studied the foraging behaviour and adaptive strategies of the Grey-headed Bulbul *Pycnonotus priocephalus*, an endemic species of the Western Ghats, India, in relation to seasons and reproductive stages in two tropical rainforest sites, Silent Valley National Park and Muthikkulam Reserve Forest, from 2002 to 2005 and 2012 to 2013. The species was recorded to use various foraging manoeuvres and food handling techniques, and was found to frequently use energy conserving manoeuvres and feeding techniques such as gleaning and gulping. There were significant differences in its foraging height and foraging tree use due to differential habitat selection during the breeding and non-breeding seasons. It showed plasticity in the foraging behaviour during the different reproductive stages. Its participation in mixed-hunting flocks during the local migratory phase (non-breeding season) seems to be an adaptive strategy to cope with resource competition and predation risks in a new and challenging habitat, which is in accordance with other studies on the flocking behaviour of tropical birds.

Key words: behavioural plasticity, foraging behaviour, Grey-headed Bulbul, mixed-species flocks, *Pycnonotus priocephalus*, Western Ghats

INTRODUCTION

Studies of foraging behaviour are central to explaining patterns in nature because survival and reproduction depend, ultimately, on an individual's success in acquiring and using energy from food resources (Hutto 1990). An understanding of the foraging manoeuvres, foraging height, and foraging site characteristics are also important in answering questions concerning co-existence and ecological segregation of similar species (Lack 1971). Moreover, information on the temporal changes in foraging strategies could be of vital importance for formulating strategies to conserve rare species. It has been widely demonstrated that food abundance and distribution are the primary determinants of foraging behaviour (reviewed in Morrison *et al.* 1990). Optimal foraging behaviour, however, may encompass other conflicting activities such as anti-predator behaviour that lead animals to trade food intake rate against other activities. Decision-making based on trade-offs may be influenced by the internal state of the animal (Krebs and Kacelnik 1991). Closely related birds nearly always show differences in the frequency of use of foraging manoeuvres (Root 1967). Theory and empirical evaluation of adaptations dictate that morphological features designed to perform one type of movement are unlikely to be well-designed for other types of movements (Moermond 1990).

Variations in foraging behaviour between sexes or during the seasons are well-known, and those associated with the stages of breeding cycle are pronounced (Brennan and Morrison 1990; Dobbs and Martin 1998; Sakai and Noon 1990). Moreover, behavioural and morphological traits that affect foraging efficiency would be adapted in part to the diet available during the periods when food limits survival or reproduction (Martin and Karr 1990). Thus, knowledge of partitioning of a species' foraging niche by sex or season is essential to increase our understanding of its life history.

Multi-species foraging flocks are a widespread phenomenon in both tropical and temperate forests. Two principal selective advantages thought to favour the evolution of mixed-species flocking behaviour are decreased predation and increased foraging efficiency (Chen and Hsieh 2002; Jullien and Thiollay 1998; Sridhar *et al.* 2009). However, it can also lead to increased intraspecific competition, particularly when food is a limiting factor (Milinski and Parker 1991). Numerous studies on mixed-species flocks have been conducted in the tropics (see Chen and Hsieh 2002; Jullien and Thiollay 1998; Sridhar *et al.* 2009 for reviews). Many endemic species of the Western Ghats of India are known to participate in mixed-species flocks (Goodale *et al.* 2009), but there is lack of detailed information on the flock feeding strategies of these species.

I carried out a study on the foraging behaviour and adaptive strategies of Grey-headed Bulbul *Pycnonotus priocephalus*, one of the 16 range-restricted bird species of the Western Ghats in relation to seasons and breeding stages. This species is listed as a Near Threatened species (BirdLife International 2014) owing to habitat loss and complex life history characteristics (Balakrishnan 2007, 2011). It has a very limited distribution in the heavy rainfall areas along the south-western region of India, from Belgaum and Goa south through Kerala, and east to the Nilgiris and Palnis, western Mysore and Coorg; from the plains to *c.*1,000 m, rarely to 1,800 m; optimum zone between 600 m and 900 m (Ali and Ripley 1987). Recent studies show a distinct patchy distribution of the species within the breeding sites and regular seasonal migration at the end of the breeding season (Balakrishnan 2007). The species is known to feed on fruits of several plant species, which include many canopy and sub-canopy trees, shrubs, lianas, and epiphytes, and insects (Ali and Ripley 1987; Balakrishnan 2007).

STUDY AREA

The study was undertaken during 2002–2005 and 2012–2013 in Silent Valley National Park (89.52 sq. km; 11° 00′–11° 15′ N; 76° 15′–76° 35′ E; 658–2,383 m above msl) and Muthikkulam Reserve Forest (63.83 sq. km; 10° 56′–10° 59′ N; 76° 41′–76° 45′ E; 610–2,065 m above msl) in the Western Ghats, both the sites separated by an area about 30 sq. km of human-modified landscape. The vegetation of both the study sites is dominated by west coast tropical evergreen forest, followed by southern montane wet temperate forest with grasslands restricted mainly to the higher slopes and hill tops. Silent Valley receives comparatively higher rainfall during the south-west monsoon (>6,000 mm/yr) than Muthikkulam (4,500 mm/yr). All the breeding season data were collected from Silent Valley, and data for non-breeding season and mixed-hunting flocks were from Muthikkulam, due to the complete absence of the study species in the former site consequent to the altitudinal migration during June to December. Further descriptions of the two study areas are available elsewhere (Balakrishnan 2007; Basha 1999; Nair and Balasubramanyan 1985).

METHODS

Foraging behaviour

The foraging behaviour of the Grey-headed Bulbul was studied by the methods described by Remsen and Robinson (1990), the observations recorded while walking slowly through existing trek paths and animal trails. For each foraging observation, the foraging manoeuvre, substrate used (twig, leaf, flower, and air), height of the foraging location, species and height of the foraging tree, the horizontal position of the bird in the canopy (nine categories: three vertical and and three horizontal), and foliage density at the foraging site (calculated as percentage cover within a one metre radius around the bird) were recorded. The relative foraging height was calculated as the foraging height relative to the height of the tree (foraging height of bird/tree height). The fruits consumed were identified by direct observations. Attempts to identify arthropod component of the diet were not successful due to poor visibility in the rainforest canopies.

Foraging manoeuvres and food handling techniques were again categorized based on Remsen and Robinson (1990). The major near-perch manoeuvres were classified as: (i) *glean* [pick food items from a nearby substrate (including from the ground) that can be reached without full extension of legs or neck, with no acrobatic movements involved]; (ii) *reach* (extend completely the legs or neck upwards, outwards, or downwards to reach food); (iii) *hang* (use legs and toes to suspend the body below the feet to reach food that cannot be reached from any other perched position); and (iv) *lunge* (manoeuvres in which the food item is beyond *reach*, and rapid leg movements rather than flight are used to reach and obtain the food item). Aerial manoeuvres were grouped as: (i) *sally* (to fly from a perch to obtain a food item and then return to a perch), and (ii) *leap* (launch into the air to reach a food item too far for a *reach* but too close for a *sally*. This differs from *sally* in that the upward thrust seems to come mostly from leg movements rather than wing movements).

The major food handling techniques recorded were classified as: (i) *gulp* (to swallow upon capture/contact without any noticeable manipulation other than being held briefly in the bill), (ii) *engulf* (to capture and swallow in one continuous motion without being held by the bill), and (iii) *bite* (to bite and remove a section of the food item).

Breeding birds were observed to study the heterogeneity in foraging behaviour within the breeding season (mid January to mid May), the reproductive stages categorized as pre-incubation, incubation, brooding, and post-brooding.

Participation in mixed-hunting flocks

Mixed-species flocks are defined after Stotz (1993) as "associations between two or more species moving in the same direction for at least 5 min". The Grey-headed Bulbul participated in mixed-hunting flocks only during the non-breeding season. Once a mixed-hunting flock with the Grey-headed Bulbul was located, it was followed for up to an hour or till it disappeared from sight. For each flock, I recorded the number of species and their individual numbers. To minimize duplication of observations, I excluded multiple flocks encountered in the same area. For each foraging individual, data were collected on the foraging behaviour, foraging positions, substrate, and food plants. To determine the foraging diversity of the major participants of mixed-hunting flocks, I recorded a single foraging event for each bird in the flock. The foraging niche-breadth of mixed-flock participants was calculated following Levins (1968): $\beta = 1 / \Sigma P_i^2$. The foraging niche-overlap (Pianka 1973) between the Grey-headed Bulbul and other flock participants was calculated by the formula $ø_{ij} = \Sigma P_{ij} P_{ik} / \sqrt{\Sigma P^2_{ij} P^2_{ik}}$, where $ø_{ij}$ = Pianka's measure of niche overlap between species j and species k, P_{ij} = proportion resource *i* is of the total resource used by species j, and P_{ik} = proportion resource *i* is of the total resource used by species k.

To understand the advantages of flock participation on foraging behaviour, I compared the foraging intensity (feeding rate/minute) of solitary non-breeders in the non-breeding site (Muthikkulam) with those foraging in mixed-species flocks from the same study site. The feeding rates were assessed during focal sampling of two-minutes duration. Foraging samples where interactions between the bird species occurred (e.g., chases) were omitted. The influence of prey-density on the feeding rate was not considered since both the feeding samples were collected during same period and from the same site.

RESULTS

Foraging manoeuvre

Based on the 1,827 foraging records of the Grey-headed Bulbul, the species was recorded to mostly forage in pairs (89%), and rarely in flocks. The diet comprises fruits (65.57%), invertebrates (34.26%), and the remaining nectar. Gleaning was the most preferred foraging manoeuvre (70.17%), followed by reach (14.01%), hang (9.30%) and sally (5.58%). Of the different techniques used to catch insects, gleaning was the most used manoeuvre (Chi-square test: $\chi^2 = 482.23$; $df = 4$; $n = 626$; $P < 0.001$). Gulping was the most used food handling technique. The Grey-headed Bulbul handled smaller fruits, arthropods, and lepidopteran larvae by either gulping or engulfing, while larger fruits of *Persea macrantha*, *Leea indica*, *Litsea floribunda*, *Syzygium* spp., and *Symplocose racemosa*, and larger insects were pecked and eaten.

Foraging locations

The mean foraging height was 4.49 ±2.52 m (range: 1–20 m) and the mean height of trees used for foraging was 5.78 ±3.30 m (range: 1–22 m). The birds foraged more in the upper (36.20%) and middle edges (23.44%) of the canopy. Foraging at the edges was significantly higher than in the inner areas of the canopy (Chi-square test: $\chi^2 = 1162.46$; $df = 5$; $n = 1826$; $P < 0.01$). The average foliage density at the point of observations was 33.76 ±18.37% (range: 2–80%).

Seasonal variation in foraging during the breeding and non-breeding seasons

Overall, there were no marked changes in the diet of Grey-headed Bulbul during the breeding and non-breeding seasons. Fruits were the most preferred food during breeding (66.09%) and non-breeding seasons (63.95%), followed by invertebrates (33.69% and 36.05% respectively), the remaining nectar. However, the fruit species consumed varied between the seasons. *Symplocos cochinchinensis*, *Antidesma menasu*, *Clerodendrum viscosum*, *Syzygium cumini*, and *Litsea floribunda* were the more preferred fruits during the breeding season, and *Maesa indica*, *Callicarpa tomentosa*, *Leea indica*, and *Lantana camara* during the non-breeding season.

Foraging manoeuvres and food handling techniques were consistent during the breeding and non-breeding seasons (Fig. 1). There were significant differences in the height of trees used for foraging (mean ± S.E: 6.41 ±3.39 m *vs* 3.81 ±1.98 m; Mann-Whitney *U*-test: $z = -16.36$; $P < 0.001$) and the foraging height (mean ± S.E: 5.01 ±2.60 m *vs* 2.88 ±1.29 m; Mann-Whitney *U*-test: $z = -18.01$; $P < 0.001$) between the breeding ($n = 1{,}386$) and non-breeding ($n = 441$) seasons. During the breeding season, birds foraged more in

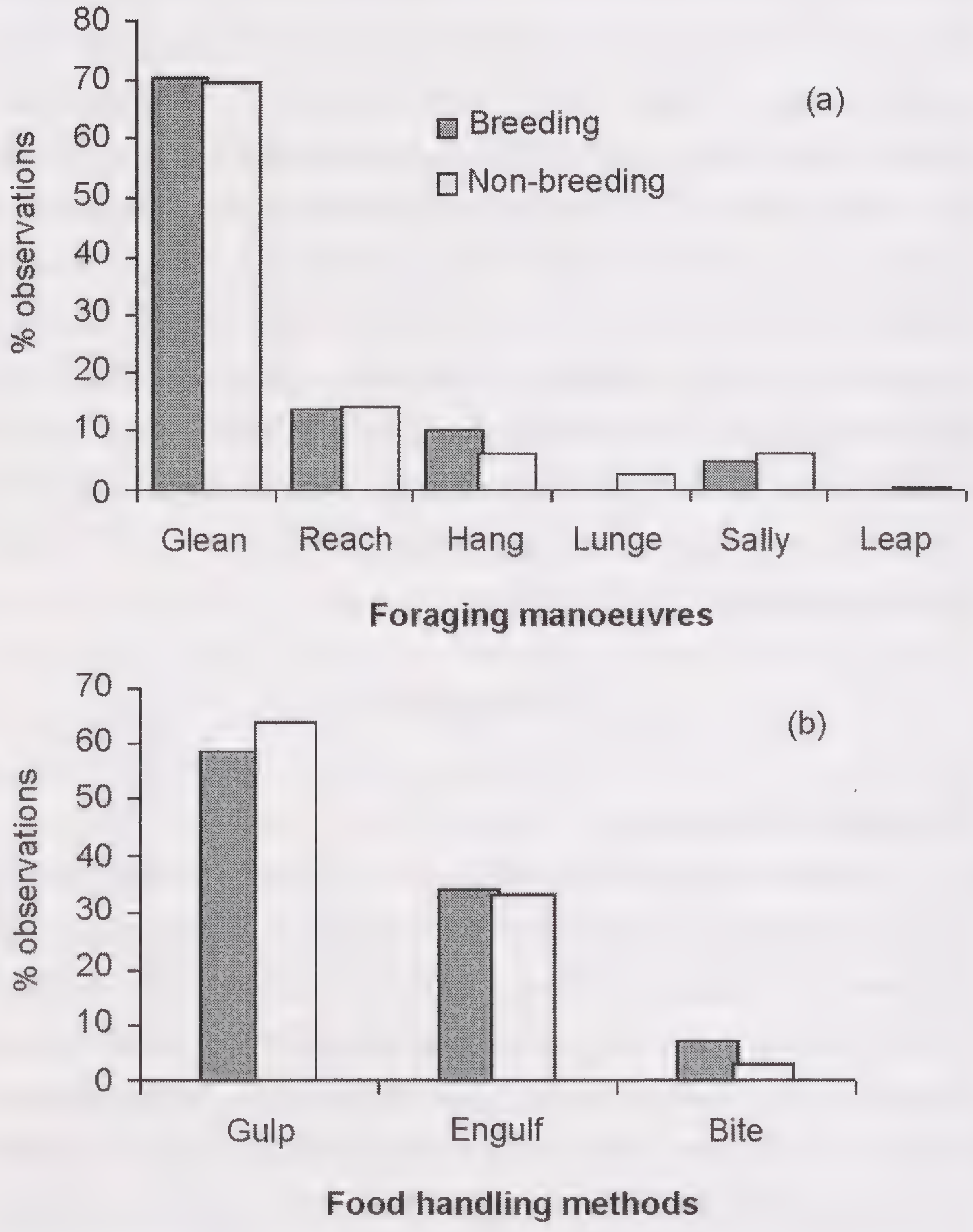

Fig. 1: (a) Foraging manoeuvres and (b) food handling methods of Grey-headed Bulbul during the breeding ($n = 1{,}386$) and non-breeding ($n = 441$) seasons

the upper canopy, while it was more in the understorey shrubs during the non-breeding season, but there was no significant difference in the relative foraging heights (relative to the height of the foraging tree) between the breeding and non-breeding seasons (Mann-Whitney *U*-test: $z = -0.777$; $P = 0.437$). Foraging at the edges was significantly higher than in the inner canopy during both the breeding (Chi-square test: $\chi^2 = 955.94$; $df = 2$; $n = 1,384$; $P < 0.01$) and non-breeding seasons (Chi-square test: $\chi^2 = 203.08$; $df = 2$; $n = 440$; $P < 0.01$; Fig. 2).

Annual variation in foraging

There was no significant annual variation in the foraging height use (ANOVA: $F_{2,1382} = 2.783$, $P = 0.062$), but the height of foraging trees (ANOVA: $F_{2,1382} = 21.004$, $P < 0.001$) and the relative foraging heights ($F_{2,1382} = 86.900$, $P = 0.001$) varied between the years (2003–2005) during the breeding seasons (Table 1). In contrast, the yearly variations in all these three parameters were prominent during the non-breeding seasons (ANOVA: $F_{2,438} = 17.525$, 29.236, and 35.093 respectively, $P < 0.001$; Table 1).

Heterogeneity of foraging behaviour within the breeding cycle

The Grey-headed Bulbul showed significant plasticity in foraging behaviour during the different reproductive stages. Although the foraging behaviour varied between the reproductive stages, gleaning was the dominant method in all the stages (Fig. 3). There were significant differences in the mean height of trees used for foraging, and also in the mean foraging height (Table 2). During the incubation and brooding stages, bulbuls foraged on taller trees, however, the relative foraging height was less during these stages ($P < 0.001$, Table 2). Moreover, the birds foraged more in areas with high foliage cover during the incubation and

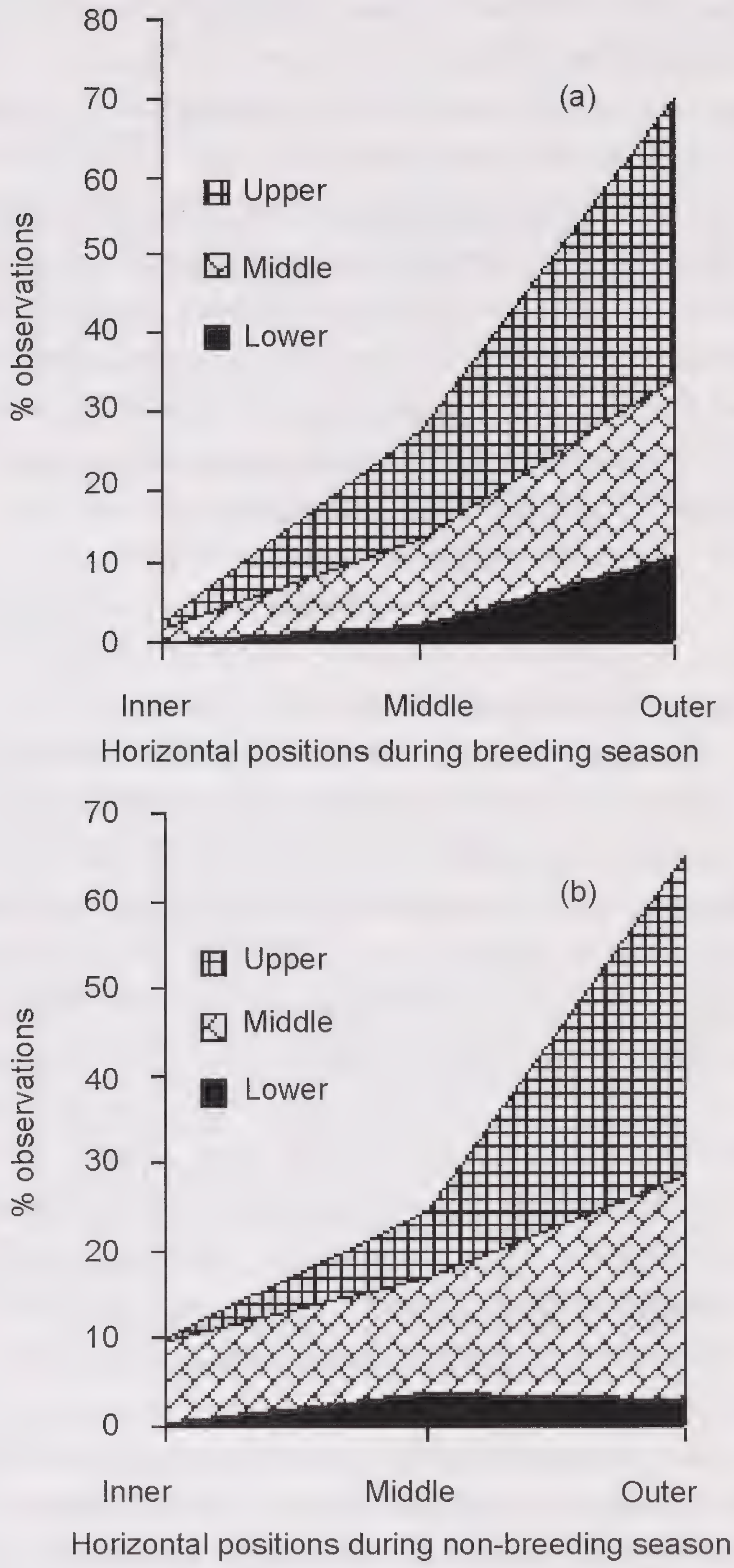

Fig. 2: Horizontal position use in canopy by the Grey-headed Bulbul during the (a) breeding and (b) non-breeding seasons

Table 1: Foraging height, height of the foraging tree, and relative foraging height during the breeding and non-breeding seasons of the Grey-headed Bulbul

Breeding Season					
Variable	2003	2004	2005	*F*	*P*
Foraging height (m)	5.39 ±2.86	4.90 ±2.77	4.99 ±2.20	2.783	0.062
Height of foraging tree (m)	7.36 ±3.95	6.63 ±3.68	5.69 ±2.42	21.004	0.001
Relative foraging height	0.76 ±0.18	0.76 ±0.18	0.89 ±0.17	86.900	0.001
Non-breeding Season					
Variable	2002	2003	2004	*F*	*P*
Foraging height (m)	2.62 ±0.97	3.49 ±1.62	2.77 ±1.24	17.525	0.001
Height of foraging tree (m)	3.66 ±1.61	4.96 ±2.63	3.18 ±1.46	29.236	0.001
Relative foraging height	0.76 ±0.18	0.74 ±0.18	0.90 ±1.70	35.093	0.001

Variable expressed as mean ±SE and *P* values after Bonferroni correction

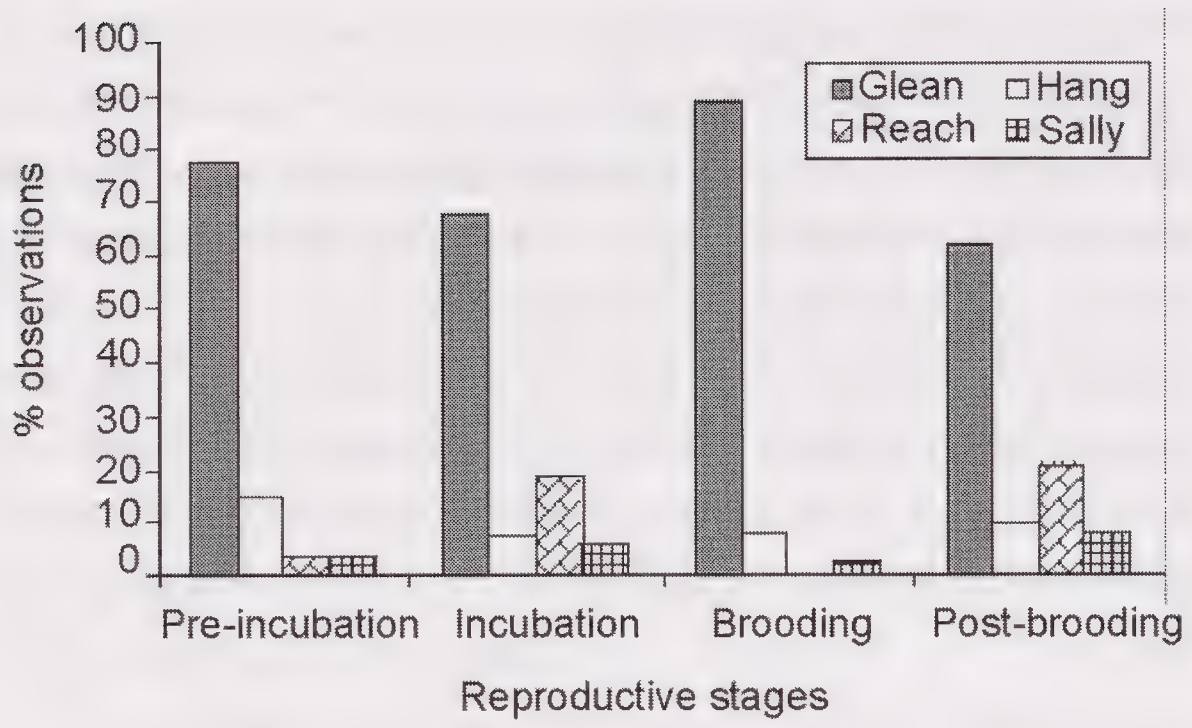

Fig. 3: Foraging methods of Grey-headed Bulbul during the different stages of reproduction (*n* = 324)

brooding stages than the other breeding stages (ANOVA: $F_{3,320} = 7.261$; $P < 0.001$).

Foraging in mixed-species flocks

The Grey-headed Bulbul was recorded foraging in 54 mixed-species flocks during the non-breeding season, associating with a total of 27 species (Table 3). The mean number of species per flock was 6.46 ±2.03 species (range: 3–11 species), and the mean number of individuals per flock was 21.94 ±8.90 birds (range: 8–53 birds). Table 4 gives the foraging niche breadth of ten common species involved in the mixed-hunting flocks, calculated from data on foraging manoeuvre, foraging height, height of the foraging tree, horizontal position in the canopy, and food items. The White-bellied Blue Flycatcher *Cyornis pallipes*, Asian Paradise-Flycatcher *Terpsiphone paradisi*, Common Iora *Aegithinia tiphia*, Grey-headed Canary-Flycatcher *Culicicapa ceylonensis*, and Yellow-browed Bulbul *Iole indica* had larger niche breadths than the Grey-headed Bulbul (Table 4). Even though the Grey-headed Bulbul was recorded to have generalized foraging manoeuvres, food, and use of canopy in mixed-foraging flocks, it is a specialist in terms of the selection of foraging trees and use of foraging heights (Table 4).

Although the foraging niche overlap with the Grey-headed Bulbul was high for some of the foraging attributes, most species exhibited a relatively low, overall foraging niche overlap with it (Table 5). Since most of the species (and the Grey-headed Bulbul) devoured insects during mixed-species foraging, a high overlap (ø >90) for food occurred. Although the Yellow-browed Bulbul and Common Iora showed high overlap in the foraging height with the Grey-headed Bulbul, canopy use varied significantly among them. The foraging intensity of Grey-headed Bulbul differed in the absence or presence of mixed-flocking species, showing a significantly higher feeding rate in mixed-flocks (8.29 ±0.16 pecks/min; $n = 171$) *vs* (4.70 ±0.10 pecks/min in their absence; $n = 240$; ANOVA: $F_{1,409} = 379.604$; $P < 0.001$).

DISCUSSION

Foraging behaviour and diet

The Grey-headed Bulbul uses a number of foraging manoeuvres and food handling techniques, of which gleaning was the most frequently used method to obtain both fruits and invertebrates. Gleaning is an energy conserving foraging technique as it involves only a simple pick of the food items from a nearby substrate without the full extension of legs, neck, or any acrobatic movements. Other manoeuvres such as reach, hang, and sally were used only when a fruit or an insect could not be obtained from a perch. The food handling techniques of the Grey-headed Bulbul were found to vary with the size of food items – handling small fruits and arthropods by engulfing or gulping, and larger fruits such as *Persea macrantha*, *Litsea* spp. and *Syzygium* spp. by biting.

Bulbuls are reported to use a variety of foraging behaviour based on food resources. Ali (1932) reported that the Red-vented Bulbul *Pycnonotus cafer* nipped open mature buds of mistletoe (Loranthaceae) and probed into the exposed corolla tubes for nectar. In Africa, species such as *Criniger barbatus* and *Andropadus tephrolaemus* took all their fruits from a perch, while another species *Andropadus latirostris* frequently used its wings to pick a fruit while fluttering or flying (Moermond 1990). Gleaning of fruits while airborne has also been recorded in the Square-tailed Black Bulbul *Hypsipetes ganeesa* in southern India (P. Balakrishnan, *unpubl.*). The Grey-headed Bulbul used aerial manoeuvres

Table 2: Foraging height, height of the foraging tree, and relative foraging height of Grey-headed Bulbul during the different stages of reproduction

Variable	Pre-incubation	Incubation	Brooding	Post-brooding	*F*	*P*
Foraging height (m)	4.79 ±2.29	6.73 ±2.03	6.08 ±1.84	5.40 ±2.14	14.811	0.001
Height of foraging tree (m)	6.55 ±3.40	9.31 ±2.99	9.31 ±3.16	6.40 ±2.54	22.404	0.001
Relative foraging height	0.76 ±0.16	0.74 ±0.17	0.68 ±0.13	0.86 ±0.17	11.447	0.001

Variables expressed as mean ±SE and *P* values after Bonferroni correction

Table 3: Frequency of occurrence and flock characteristics of mixed-species flocks associated with Grey-headed Bulbul in Muthikkulam Reserve Forest

Sl. No.	Bird species	No. of flocks	Frequency of occurrence	Mean flock size	SE	Min. & Max. no./flock
1	Grey-headed Bulbul *Pycnonotus priocephalus*	54	100.00	1.87	0.39	1-3
2	Indian Scimitar-Babbler *Pomatorhinus horsfieldii*	27	50.00	4.81	1.39	2-7
3	Grey-headed Canary-Flycatcher *Culicicapa ceylonensis*	24	44.44	10.17	5.80	4-24
4	Yellow-browed Bulbul *Iole indica*	19	35.19	2.21	0.92	1-4
5	White-bellied Blue Flycatcher *Cyornis pallipes*	18	33.33	1.78	0.43	1-2
6	White-bellied Treepie *Dendrocitta leucogastra*	17	31.48	5.53	1.55	2-9
7	Asian Paradise-Flycatcher *Terpsiphone paradisi*	17	31.48	1.94	0.43	1-3
8	Common Iora *Aegithinia tiphia*	14	25.93	1.86	0.36	1-2
9	Dark-fronted Babbler *Rhopocichla atriceps*	13	24.07	8.08	2.56	5-12
10	Oriental White-eye *Zosterops palpebrosa*	13	24.07	7.00	2.83	3-13
11	Black-lored Yellow Tit *Parus xanthogenys*	12	22.22	1.83	0.58	1-3
12	Black Drongo *Dicrurus macrocercus*	12	22.22	1.83	0.39	1-2
13	Scarlet Minivet *Pericrocotus flammeus*	11	20.37	2.00	0.00	2-2
14	Greater Racket-tailed Drongo *Dicrurus paradiseus*	11	20.37	1.91	0.30	1-2
15	Common Flameback *Dinopium javanense*	11	20.37	1.82	0.40	1-2
16	Red-whiskered Bulbul *Pycnonotus jocosus*	9	16.67	3.22	3.03	1-11
17	Square-tailed Black Bulbul *Hypsipetes ganeesa*	8	14.81	5.88	3.04	2-12
18	Brown-cheeked Fulvetta *Alcippe poioicephala*	8	14.81	2.13	0.35	2-3
19	Rufous Treepie *Dendrocitta vagabunda*	7	12.96	1.71	0.49	1-2
20	White-cheeked Barbet *Megalaima viridis*	8	14.81	1.75	0.46	1-2
21	Velvet-fronted Nuthatch *Sitta frontalis*	7	12.96	1.86	0.38	1-2
22	Heart-spotted Woodpecker *Hemicircus canente*	7	12.96	1.57	0.53	1-2
23	Black-headed Oriole *Oriolus xanthornus*	6	11.11	1.67	0.52	1-2
24	Asian Fairy-Bluebird *Irena puella*	5	9.26	2.00	0.00	2-2
25	Small Minivet *Pericrocotus cinnamomeus*	5	9.26	1.80	0.45	1-2
26	Black-naped Blue Monarch *Hypothymis azurea*	4	7.41	1.25	0.50	1-2
27	Malabar Barbet *Megalaima malabarica*	2	3.70	1.50	0.71	1-2

Table 4: Foraging niche-breadths of the common bird species recorded in the mixed-species flocks (n=10) with Grey-headed Bulbul

Species	Niche breadth					
	Foraging manoeuvre	Foraging height	Foraging tree height	Horizontal position in canopy	Food	Overall
Grey-headed Bulbul	4.25	2.87	2.91	3.65	1.56	3.05
Indian Scimitar-Babbler	2.08	2.11	2.08	1.95	1.42	1.93
Grey-headed Canary-Flycatcher	4.38	4.33	4.92	2.40	1.12	3.43
Yellow-browed Bulbul	2.53	4.74	4.61	3.57	1.69	3.43
White-bellied Blue Flycatcher	3.76	4.38	4.59	5.83	1.10	3.93
White-bellied Treepie	2.87	2.17	3.66	3.90	1.41	2.80
Asian Paradise-Flycatcher	4.15	5.38	4.46	3.85	1.06	3.78
Common Iora	4.03	3.74	2.60	5.33	1.53	3.45
Dark-fronted Babbler	2.34	3.06	2.99	3.84	1.05	2.66
Oriental White-eye	1.34	4.26	3.31	4.27	1.87	3.01

Table 5: Foraging niche overlap of Grey-headed Bulbul with common species in mixed-species flocks (*n*=9)

Species	Niche overlap					
	Foraging manoeuvre	Foraging height	Foraging tree height	Horizontal position in canopy	Food	Overall
Indian Scimitar-Babbler	0.60	0.04	0.15	0.03	0.99	0.36
Grey-headed Canary-Flycatcher	0.88	0.74	0.79	0.02	0.96	0.68
Yellow-browed Bulbul	0.88	0.89	0.78	0.02	0.54	0.62
White-bellied Blue Flycatcher	0.80	0.37	0.49	0.06	0.96	0.54
White-bellied Treepie	0.69	0.02	0.15	0.03	0.97	0.37
Asian Paradise-Flycatcher	0.79	0.49	0.73	0.20	0.96	0.63
Common Iora	0.89	0.86	0.91	0.03	0.99	0.74
Dark-fronted Babbler	0.86	0.52	0.99	0.28	0.96	0.72
Oriental White-eye	0.74	0.74	0.94	0.03	0.32	0.55

while hunting insects among the foliage. The differential strategies used by the Grey-headed Bulbul for obtaining fruits and insects indicate its flexibility in the use of foraging techniques based on the type and size of resources.

Fruits were the most preferred food of Grey-headed Bulbul, followed by insects and nectar. This is similar to patterns reported for the majority of pycnonotids, which are essentially frugivores that augment their diet with a certain amount of arthropod food (Ali and Ripley 1987; Bhatt and Kumar 2001; Fishpool and Tobias 2005; Vijayan 1975). However, a significant number of species, mostly in Africa and Madagascar, are insectivorous, some with quite specialized niches (Fishpool and Tobias 2005). Many open country species are skilled opportunists and extreme generalists. The Yellow-vented Bulbul *Pycnonotus goiavier* of Southeast Asia, for example, has one of the broadest foraging niches yet measured among non-forest passerines studied globally (Fishpool and Tobias 2005). In this study, I did not record any significant variation in the proportionate use of fruits and arthropods by the Grey-headed Bulbul between the breeding and non-breeding seasons.

Although the Grey-headed Bulbul uses similar general foraging strategies for the breeding and non-breeding seasons, there were differences in the foraging height and foraging tree use. During the breeding season, birds foraged at an average height of 5 m, while it was below 3 m during the non-breeding season. Similarly, the height of the trees selected for foraging was also considerably lower during the non-breeding season (3.81 m) than in the breeding season (6.41 m). These variations could be mainly due to the differences in the vegetation structure of the breeding and non-breeding habitats, as they were restricted to the evergreen forests during the breeding season, and in the lowland evergreen forests, moist deciduous forests, and thorny scrub during the non-breeding season. However, the relative foraging height (relative to the height of the foraging tree) was the same during both the seasons, since the species preferred the inner canopy zone, probably to avoid predators and/or to avoid dominant competitors. Although fruits in the majority of the plants were congregated at the periphery, the Grey-headed Bulbul tended to forage inside the canopy, while the other dominant and larger species such as Square-tailed Black Bulbul, Yellow-browed Bulbul, and pigeons foraged at the extreme periphery of the canopy. This indicates that the Grey-headed Bulbul has a specialized foraging niche, presumably due to competition with congeners, and species with similar food resources. The intra-species variation in the heights of the fruit bearing trees could be a plausible reason for the annual variations in the foraging heights.

Behavioural plasticity within the breeding seasons

Birds have to resolve many constraints during incubation and brooding compared to other stages of their life cycle. Changes in foraging behaviour during the different nesting stages have received limited attention, but energy expenditure and acquisition during differing stages of breeding are critical elements in understanding life history strategies (Martin 1987). The Grey-headed Bulbul showed significant variations in foraging behaviour during the different breeding stages. These variations could be considered as the responses of birds to time or energy constraints, or changing prey availability and distribution (Root 1967). During all the stages, breeding bulbuls foraged away from the nest sites, probably to reduce parental activity at the nest sites to help reduce nest predation (Balakrishnan 2007). Similar observations were reported by several authors (e.g., Martin *et al.* 2000; Fontaine and Martin 2006). Foraging in areas with high foliage density during the incubation and brooding stages could reduce predation risks. Although gleaning was, overall, the most frequently used foraging manoeuvre during the breeding season, energetically expensive manoeuvres such as sallying were higher towards the end of the nestling stage. Feeding rates were significantly higher during the incubation and brooding periods, as reported in many previous studies (Lovette and Holmes 1995; Martin and Karr 1990). The rapid foraging rates during the incubation and nestling stages compared to the egg-laying stage suggests that incubation may also place time constraints on females, requiring them to forage speedily and return to the nest quickly (Dobbs and Martin 1998; Sakai and Noon 1990). The tradeoff between the thermal needs of the eggs and the energy needs of the adult could be overcome by this increased feeding rate. Therefore, it is clear that breeding birds use different behavioural mechanisms to cope with energetic constraints and predation risks.

Mixed-hunting, and its significance in the non-breeding season

Many species of insectivorous birds in both the temperate and tropical latitudes are known to gather in mixed-hunting flocks during the non-breeding season (Chen and Hsieh 2002; Jullien and Thiollay 1998). There could be several advantages for a species to be associated with mixed-hunting flocks. An individual may increase its rate of food capture by associating with other individuals. For example, among the insect-eating birds, flocking may be advantageous because prey may be flushed by the activities of other individuals. Another advantage of flocking behaviour is the reduction in predation rates. Moreover, grouping may have an anti-predator function by the mobbing responses of several species (see Chen and Hsieh 2002; Jullien and Thiollay 1998).

The Grey-headed Bulbul was recorded to participate in mixed-hunting flocks led by different nucleus species during the non-breeding season. The most numerous participants in mixed-species flocks were resident species of the area, most being insectivores. On an average, the flocks consisted of around six species comprising totally *c.* 21 individuals. Although identification of the nucleus species in many of these mixed-species flocks was difficult, the White-bellied Treepie *Dendrocitta leucogastra* and Common Flameback *Dinopium javanense* appeared to be the 'leaders' in several flocks. The alertness of the nucleus species and its propensity to give alarm calls could be the greatest incentive for attendant species to join the flock and exploit them further (Sullivan 1984). Several species appeared as sentinel species, and were recorded giving alarm calls at the approach of predators. The Common Flameback, Indian Scimitar-Babbler *Pomatorhinus horsfieldii*, Dark-fronted Babbler *Rhopocichla atriceps*, and Brown-cheeked Fulvetta *Alcippe poioicephala* gave repeated alarm calls when predators approached. In Peru, Munn (1986) reported that the flock members rely mainly on the alarm calls of the sentinel species in the understorey and canopy flocks. A similar alertness of both nucleus and sentinel species on the approach of predators was common in the flocks observed, which lends support to this foraging efficiency and anti-predator hypothesis, and justifies the participation of the Grey-headed Bulbul during non-breeding season in mixed-hunting flocks.

Preference of arthropod food by the Grey-headed Bulbul during mixed-species flocking resulted in a high food niche overlap with most of the flock members. It hunted for arthropods in the middle or outer canopy, using several foraging manoeuvres, and avoided the upper canopy where the highly niche-overlapping, generalist species such as Yellow-browed Bulbul *Iole indica* and Common Iora *Aegithinia tiphia* were abundant. Although it is restricted to certain heights, apparently due to the presence of other species with similar niches, it showed much generalized foraging manoeuvres and use of horizontal positions in the canopy during flock participation. The Grey-headed Bulbul was seen to associate with flocks having the Square-tailed Black and Red-whiskered Bulbuls at Muthikkulam, but the number of observations was not sufficient to work on niche overlaps. In the lower altitude, non-breeding habitats (scrub forest), it also associated with other bulbuls, namely, Red-vented Bulbul *Pycnonotus cafer* and White-browed Bulbul *Pycnonotus luteolus*. The foraging rate was significantly higher while foraging in mixed-species flocks than those of singletons.

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THYSANOPTERA (INSECTA) FAUNA OF THE KEIBUL LAMJAO NATIONAL PARK, MANIPUR, NORTHEAST INDIA

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Our study reports 119 thrips species of 74 genera from Keibul Lamjao National Park (KLNP), Manipur. Out of 119 species collected during the study, 48 are endemic to India, and 22 are recorded for the first time from Manipur. *Mycterothrips auratus* Wang (1999), earlier known from China and Taiwan, has been collected for the first time from India.

Key words: Thysanoptera, Thrips fauna, Keibul Lamjao National Park, Thrips diversity, Manipur

INTRODUCTION

Order Thysanoptera includes an important group of insects commonly known as thrips, with body size ranging from 0.5–15 mm in length and possessing unique features like the presence of fringes on wings, asymmetrical mouth parts (only left mandible functional, right mandible vestigial), protrusible bladder-like structure at the tip of tarsus, and occurrence of pre-pupal stage between larval and pupal stages. Thrips are mainly sporophagous as well as phytophagous, while a few are predatory. A perusal of the literature indicates that nearly 95% of suborder Terebrantia depend on green plants, and about 60% of suborder Tubulifera are mycophagous (Mound 2005). Their adaptive feeding has enabled successful exploitation of diverse niches such as leaf, flower, plant galls, litter, grass clumps, and dry twigs. Though the majority of them are benign, some thrips are involved in inducing plant galls, and a few act as pollinators, vectors, and pests (Ananthakrishnan 1993). About 300 species of thrips belonging to 57 genera are gall makers, and the nature of the galls reflects insect phylogenetic relationships (Crespi *et al.* 1997). Thrips in general exhibit varied levels of sociality and remarkable structural polymorphism (Izzo *et al.* 2002). The world checklist records nearly 7,400 species groups (Mound n.d.: www.ento.csiro.au/thysanoptera/worldthrips.php) including about 700 species from the Indian subcontinent, of which 200 species have been reported from NE India (Varatharajan 2005). Although faunistic survey of thrips in certain parts of Manipur has been made earlier (Chochong 2004; Muraleedharan 1982; Varatharajan 1999), the Keibul Lamjao National Park (KLNP) has not been studied so far, probably due to its exclusiveness and restricted entry imposed to conserve the Sangai Deer *Rucervus eldii eldii* McClelland which is known to occur only in this floating park. Therefore, a maiden survey was undertaken during 2010–2012 to study the faunal composition of thrips at KLNP.

MATERIAL AND METHODS

Thrips survey was carried out at the Keibul Lamjao National Park (KLNP) (24° 27′–24° 31′ N, 93° 53′–93° 55′ E; 767–788 m above msl), that spreads over an area of 40 sq. km. KLNP is positioned at the south-eastern corner of Loktak lake, which is present in the Bishnupur district of Manipur State, and has been declared as a Ramsar site. Thrips were collected at random from diverse plants growing in different habitats and the collected specimens were preserved in the conventional collection fluid (10% ethanol, glacial acetic acid and glycerol in 9:1:1 ratio with a few drops of Triton-X) (Bhatti 1997). The material was later processed using standard protocol for preparing permanent slides for identification (Ananthakrishnan and Sen 1980). The collected host plants were also processed for herbarium preservation and documentation. The thrips specimens are deposited in the Department of Life Sciences, Manipur University, and also at the Indian Agricultural Research Institute (IARI), New Delhi, along with the Pusa National Collections.

RESULTS

The survey carried out at KLNP revealed the occurrence of 119 species of thrips belonging to 74 genera in four subfamilies and three families of Order Thysanoptera. *Merothrips indicus* was the only species under Merothripidae, while Thripidae under suborder Terebrantia was represented by 47 species, and Phlaeothripidae of suborder Tubulifera by 72 species. Among different genera, the following two genera *Haplothrips* and *Megalurothrips* had 5 species each, *Liothrips* had 6 species, and *Thrips* had 8 species, thus showing an average representation of 6, while the rest had 1, 2 or 3 species. This study is significant as 40% of the specimens collected are endemic, which reflects the importance of KLNP. 22 species have been recorded for the first time from Manipur during the present survey. The feeding habit and the microhabitat of each species are provided in Table 1 along with the date of collection and numbers of specimen collected. Although the present work is the outcome of a three-year survey, a continuous search will yield much more data since KLNP is completely protected by government with the help of local people.

Thrips are unique insects known for their diversity (Mound 2005). In terms of feeding habits and habitats, the collection records of the survey showed a maximum of 26 species of free living foliage thrips, 18 flower inhabiting forms, 18 mycophagous leaf-litter dwellers, 15 mycophagous

Table 1: Systematic collection record of Thrips of KLNP

Sl. No.	Name of the species with registration number	Date of collection & No. of specimens studied	Habit, microhabitats & Host plants	Distribution
	Sub order: Terebrantia			
	Family: Merothripidae			
1.	*Merothrips indicus* Bhatti & Ananthakrishnan, 1975; KLNP/MU/Lr 1	14.ix.2011 Two	Mycophagous & dry twigs	India (Manipur, Kerala, Tamil Nadu), China.
	Family: Thripidae; Subfamily: Thripinae			
2.	*Dendrothrips schimae* Kudo, 1989; KLNP/MU/Wd 1	8.v.2011 One	Weed; *Delonix regia* (Boj. ex Hook) (Fabaceae)	India (widespread), Nepal (Kathmandu).
3.	*Dendrothrips strasseni**@ Bhatti, 1971; KLNP/MU/Wd 2	8.v.2011 One	Weed; *Delonix regia* (Boj. ex Hook) (Fabaceae)	India (Manipur, Maharashtra).
4.	*Hydatothrips ananthakrishnani** Bhatti, 1973; KLNP/MU/L 1	8.v.2012 Three	Leaf; *Quercus serrata* Thunb. (Fagaceae)	India (Madhya Pradesh, Manipur, Tamil Nadu).
5.	*Hydatothrips ramaswamiahi** Karny, 1926; KLNP/MU/L 2	22.v.2012 Two	Leaf; *Vicia faba* Linn. (Fabaceae)	India (Delhi, Manipur, Tamil Nadu).
6.	*Neohydatothrips samayunkur* Kudo, 1995; KLNP/MU/Fl 1	4.xii.2011 Five	Flower; *Tegetes erecta* Linn. (Asteraceae)	India, Australia, China (Taiwan), Japan, USA (Hawaii, Florida).
7.	*Scirtothrips dorsalis* Hood, 1919; KLNP/MU/P 1	31.x.2011 Seven	Pest; *Capsicum annum* L. (Solanaceae)	India (Kerala, Karnataka, Manipur), Australia, Indonesia (Sumatra).
8.	*Sciothrips cardamomi* (Ramakrishna, 1935); KLNP/MU/P 2	14.xi.2011 Five	Pest; *Hedychium coronarium* J. Koenig (Zingiberaceae)	India (Manipur, Tamil Nadu), Costa Rica.
9.	*Anaphothrips sudanensis* Trybom, 1911; KLNP/MU/Gr 1	14.v.2011	Grass; *Imperata cylindrica* (L) P. Beauv. (Poaceae)	India (Kerala, Manipur), Australia (New South Wales), USA (Bayamon, Puerto Rico), Philippines (Bacolod), Egypt, Philippines, Trinidad, Japan (Mount Shinten), China (Taiwan), South Africa.
10.	*Rhamphothrips parviceps* (Hood, 1919); KLNP/MU/Gr 2	21.iii.2011 Two	Grass; *Erianthus procerus* (Poaceae)	India (Delhi, Madhya Pradesh, Maharashtra, Manipur, Tamil Nadu), China.
11.	*Ayyaria chaetophora* Karny, 1927; KLNP/MU/Fl 2	7.ix.2011 Four	Flower; *Phaseolus vulgaris* L. (Fabaceae)	India (Andhra Pradesh, Delhi, Haryana, Kerala, Madhya Pradesh, Maharashtra, Manipur, Tamil Nadu, Uttar Pradesh), China, Japan, Philippines.
12.	*Bolacothrips indicus** (Ananthakrishnan, 1965); KLNP/MU/Gr 3	28.ix.2011 Two	Grass; *Arundo donax* L. (Poaceae)	India (Gujarat, Kerala, Madhya Pradesh, Manipur, Tamil Nadu).
13.	*Chaetanaphothrips orchidii* (Moulton, 1907); KLNP/MU/L 3	2.v.2011 Two	Leaf; *Dendrobium chrysotoxum* Lindl. (Orchidaceae)	India (widespread), Indonesia, Japan, USA (California).

Table 1: Systematic collection record of Thrips of KLNP (*contd.*)

Sl. No.	Name of the species with registration number	Date of collection & No. of specimens studied	Habit, microhabitats & Host plants	Distribution
14.	*Craspedothrips minor* (Bagnall, 1921); KLNP/MU/Fl 3	6.vii.2011 One	Leaf; *Schima wallichii* (DC.) Korth. (Theaceae)	India (widespread), Indonesia, China (Kaohsiung Hsien, Taiwan).
15.	*Dichromothrips nakahari* Mound, 1976; KLNP/MU/Fl 4	2.v.2010 Six	Flower; *Dendrobium chrysotoxum* Lindl. (Orchidaceae)	India (Kolkata, Manipur), USA.
16.	*Euphysothrips minozzii*@ Bagnall, 1926; KLNP/MU/L 4	5.vi.2011 Two	Leaf; *Pennisetum typhoideum* Rich. (Poaceae)	India (Manipur, Tamil Nadu), France, Austria, Spain (Canary Islands), Egypt, Mozambique.
17.	*Frankliniella intonsa* (Trybom, 1895); KLNP/MU/Fl 5	14.v.2011 Five	Flower/Leaf; *Hibiscus rosa-sinensis* L. (Malvaceae)	Widespread in Asia and Europe.
18.	*Frankliniella schultzei* (Trybom, 1910); KLNP/MU/Fl 6	14.v.2011 Five	Pest/Vector; *Dahlia* sp. (Asteraceae), *Oxalis corniculata* L. (Oxalidaceae)	Cosmopolitan.
19.	*Fulmekiola serrata*@ (Kobus, 1893); KLNP/MU/Gr 4	14.vi.2012 Four	Grass; *Saccharum officinalis* (Poaceae)	Southeast Asia.
20.	*Megalurothrips distalis* (Karny, 1913); KLNP/MU/Fl 7	14.x.2012 Five	Flower; *Phaseolus vulgaris* L. (Fabaceae)	India (Arunachal Pradesh, Meghalaya, Manipur, Tamil Nadu, West Bengal), Indonesia, Sri Lanka, Philippines, Korea, Fiji.
21.	*Megalurothrips mucunae* (Priesner, 1938); KLNP/MU/Fl 8	14.x.2011 Two	Flower; *Phaseolus vulgaris* L. (Fabaceae)	India, Indonesia, Fiji (Sigatoka, Viti Levu).
22.	*Megalurothrips peculiaris* (Bagnall, 1918); KLNP/MU/Fl 9	22.x.2011 Two	Flower; *Pongamia pinnata* (L.) Pierre (Fabaceae), *Phaseolus vulgaris* L. (Fabaceae)	India (Bihar, Delhi, Karnataka, Manipur, Tamil Nadu, Uttar Pradesh), China.
23.	*Megalurothrips typicus* Bagnall, 1915; KLNP/MU/Fl 10	14.x.2011 Three	Flower; *Phaseolus vulgaris* L. (Fabaceae)	India (Andhra Pradesh, Madhya Pradesh, Maharashtra, Manipur, Tamil Nadu), Malaysia (Sarawak), Indonesia (Sumatra), China (Taiwan).
24.	*Megalurothrips usitatus* (Bagnall, 1913); KLNP/MU/Fl 11	14.x.2011 Seven	Flower; *Pongamia pinnata* (L.) Pierre (Fabaceae)	India (Manipur, Tamil Nadu), Sri Lanka, Australia, Thailand.
25.	*Microcephalothrips abdominalis* (Crawford, 1910); KLNP/MU/Fl 12	15.v.2011 Thirteen	Flower; *Eclipta prostrata* Linn., *Gynura* sp., *Tagetes erecta* L. (Asteraceae)	India (Widespread), Australia, Mexico (Jalisco), Egypt (Maadi), Georgia, USA (Colorado).
26.	*Mycterothrips auratus*@ Wang, 1999; KLNP/MU/L 5	14.vi.2011 One	Leaf; *Melia azedarach* L. (Meliaceae)	China (Taiwan) and first record for India (Manipur).
27.	*Mycterothrips ricini*@ Shumsher, 1946; KLNP/MU/L 6	3.vii.2012 One	Leaf; *Ricinus communis* L. (Euphorbiaceae)	India (Delhi, Manipur), China, Japan.
28.	*Organothrips indicus*@ Bhatti, 1974; KLNP/MU/Wd 3	22.v.2012 Five	Aquatic weed; *Eichhornia crassipes* (Mart.) Solms (Pontederiaceae)	India (Darjeeling, Delhi, Manipur), Australia, Bangladesh, Hong Kong, Thailand, USA (Florida).
29.	*Stenchaetothrips biformis* (Bagnall, 1913); KLNP/MU/L 7	14.x.2011 Five	Leaf; *Bambusa* sp. (Poaceae), *Oryza sativa* L. (Poaceae)	India (Manipur, Nagaland), Australia, Bangladesh, England, Indonesia (Sumatra), Romania.
30.	*Thrips coloratus* Schmutz, 1913; KLNP/MU/Fl 13	14.vi.2011 Four	Flower; *Eichhornia crassipes* (Mart.) Solms, (Pontederiaceae)	India (Meghalaya, West Bengal, Punjab, Himachal Pradesh), Australia, Japan, Sri Lanka.
31.	*Thrips flavus* Schrank, 1776; KLNP/MU/Fl 14	14.vi.2011 Two	Flower; *Mikania cordata* (Burm.f.) B.L. Rob. (Asteraceae)	India (Himachal Pradesh, Manipur, Tamil Nadu, Uttar Pradesh), Austria, England, Europe (Croatia), Germany, Japan, Korea, Iran, USA, China (Taiwan).

Table 1: Systematic collection record of Thrips of KLNP (*contd.*)

Sl. No.	Name of the species with registration number	Date of collection & No. of specimens studied	Habit, microhabitats & Host plants	Distribution
32.	*Thrips flavidulus* (Bagnall, 1923); KLNP/MU/L 8	21.vi.2012 Two	Leaf; *Schima wallichii* (DC.) Korth. (Theaceae)	India (Chandigarh, Himachal Pradesh, Manipur, Nagaland, Uttar Pradesh), China, Japan, Korea, Nepal, Sri Lanka.
33.	*Thrips orientalis*@ (Bagnall, 1915); KLNP/MU/Fl 15	12.iv.2012 Five	Flower; wild Jasmine flowers	India, China, Thailand, Japan, Philippines, Java, Borneo, Tahiti, USA (Hawaii), Malaysia (Sarawak), Tanzania.
34.	*Thrips hawaiiensis* (Morgan, 1913); KLNP/MU/Fl 16	14.x.2011 Five	Flower; *Ipomea palmata* Forssk. (Convolvulaceae), *Lantana camara* L. (Verbenaceae), *Melia azedarach* L. (Meliaceae), *Mikania cordata* (Burm.f.) B.L. Rob (Asteraceae)	India, Hawaii, USA, Indonesia, Japan, Fiji Australia, Sri Lanka.
35.	*Thrips palmi* Karny, I925; KLNP/MU/P 3	7.vii.2011 Seven	Pest; *Hibiscus rosa-sinesis* Linn., *Urena lobata* L. (Malvaceae)	India, Sumatra, Indonesia, Sudan, China (Taiwan), widespread in the tropics and the Caribbean.
36.	*Thrips simplex* (Morison, 1930); KLNP/MU/Fl 17	15.v.2011 Five	Flower; *Musa paradisiaca* L. (Musaceae)	India (Tamil Nadu, Manipur), South Australia, Queensland, Canada, France, South Africa.
37.	*Thrips tabaci* Lindemann, 1889; KLNP/MU/P 4	14.iv.2011 Five	Pest/Vector; *Allium cepa* L. (Amaryllidaceae)	India (widespread), Moldova, Southern Russia, USA, Austria, England, Hungary, Canada, Japan, France.
	Family: Thripidae; Subfamily: Panchaetothripinae			
38.	*Astrothrips tumiceps* Karny, 1921; KLNP/MU/Wd 4	7.xi.2010 Three	Weed; *Melia azedarach* L. (Meliaceae)	India (widespread), Indonesia, Philippines, northern Australia.
39.	*Helionothrips kadaliphilus* (Ramakrishna & Marg., 1931); KLNP/MU/L 9	14.iv.2011 Six	Leaf; *Colocasia esculenta* (L.) Schott, (Araceae), *Musa paradisiaca* L. (Musaceae)	NE India, southern India, New Guinea.
40.	*Helionothrips parvus* Bhatti, 1968; KLNP/MU/L 10	23.v.2012 Three	Leaf; *Musa paradisiaca* L. (Musaceae)	India (Manipur, Uttar Pradesh), China.
41.	*Heliothrips haemorrhoidalis* (Bouche, 1833); KLNP/MU/L 11	7.x.2011 Two	Leaf; *Ficus glomerata* Roxb. (Moraceae)	India, Australia, Germany, England, Finland, Sri Lanka, Surinam.
42.	*Panchaetothrips indicus* Bagnall, 1912; KLNP/MU/P 5	8.viii.2011 Five	Pest; *Curcuma longa* L. (Zingiberaceae)	India (Bihar, Kerala, Manipur, Tamil Nadu), China, Bangladesh, Thailand.
43.	*Phibalothrips peringueyi* (Faure, 1925); KLNP/MU/Gr 5	22.viii.2012 Seven	Grass; *Sporobolus indicus* (L.) R.Br., *Paspalum orbiculare* G. Forst. (Poaceae)	India (Manipur, Tamil Nadu, West Bengal), South Africa, Pretoria, China (Taiwan).
44.	*Retithrips syriacus* Mayet, 1890; KLNP/MU/P 6	22.x.2012 Two	Pest; *Ricinus communis* Linn. (Euphorbiaceae)	India (Kerala, Manipur, Tamil Nadu), Afghanistan, Bangladesh, Pakistan, Sri Lanka.
45.	*Rhipiphorothrips pulchellus* Morgan, 1913; KLNP/MU/L 12	4.x.2011 Two	Leaf; *Cynodon dactylon*, *Sporobolus indicus* (Poaceae)	India (Madhya Pradesh, Manipur), Afghanistan, Bangladesh, Java, Pakistan, Philippines, Sri Lanka.
46.	*Selenothrips rubrocinctus* (Giard, 1901); KLNP/MU/L 13	27.x.2010 Four	Leaf; *Quercus* sp. (Fagaceae)	India (Andaman & Nicobar Is., Kerala, West Bengal, Manipur, Assam), Philippines, China (Taiwan), Myanmar, Thailand, Bangladesh, Sri Lanka, Honduras, Mexico.

Table 1: Systematic collection record of Thrips of KLNP (*contd.*)

Sl. No.	Name of the species with registration number	Date of collection & No. of specimens studied	Habit, microhabitats & Host plants	Distribution
47.	*Zaniothrips ricini* Bhatti, 1967; KLNP/MU/L 14	5.ii.2012 One	Leaf; *Ricinus communis* Linn. (Euphorbiaceae)	India (Madhya Pradesh, Manipur, West Bengal), China.
	Sub order: Tubulifera			
	Family: Phlaeothripidae; Subfamily: Phlaeothripinae			
48.	*Adraneothrips disjunctus** Ananthakrishnan, 1972; KLNP/MU/Lr 2	21.i.2012 One	Mycophagous & Dry twigs	India (Andhra Pradesh, Manipur).
49.	*Aleurodothrips fasciapennis*@ (Franklin, 1909); KLNP/MU/Pd 1	5.vi.2010 One	Predator; *Citrus* sp. (Rutaceae)	India (Kerala, Manipur, Tamil Nadu, West Bengal), Australia, Belgium, Bermuda, China, Cuba, Indonesia, Jamaica, Japan, Nassau, Sri Lanka, Fiji, USA, Vietnam, Puerto Rico.
50.	*Androthrips flavitibia** Moulton, 1933; KLNP/MU/Pd 2	12.ii.2011 One	Predator; Dry leaves of *Lantana camara* L. (Verbenaceae)	India (Dehradun, Manipur, Assam).
51.	*Apelaunothrips consimilis* (Ananthakrishnan, 1969); KLNP/MU/Lr 3	20.ix.2010 Three	Mycophagous & litter	India (Karnataka, Kerala, Manipur), China, Japan, Malaysia, Indonesia.
52.	*Athlibothrips inquilinus** (Ananth. & Varadarasan,1978); KLNP/MU/G 1	12.xii.2012 Two	Gall inquilines; *Bixa orellana* Linn. (Bixaceae)	India (Bihar, Manipur).
53.	*Azaleothrips amabilis** Ananthakrishnan, 1964; KLNP/MU/Lr 4	14.vi.2010 Two	Mycophagous & Dry twigs	India (Tamil Nadu, Kerala, Goa, Uttar Pradesh, West Bengal, Madhya Pradesh, Maharashtra).
54.	*Baenothrips asper* (Bournier, 1963); KLNP/MU/Lr 5	4.vi.2011 One	Mycophagous & litter/Dry grass	India (Andhra Pradesh, Manipur), Angola, China.
55.	*Bamboosiella nayari* (Ananthakrishnan, 1958); KLNP/MU/Lr 6	24.ix.2011 Five	Mycophagous & litter	India (Kerala, Manipur), China.
56.	*Bamboosiella varia*@ (Ananthakrishnan & Jagadish, 1969); KLNP/MU/Lr 7	14.vi.2012 Two	Mycophagous & litter	India (Kerala, Uttar Pradesh), China, Thailand, Indonesia, Philippines, Japan.
57.	*Bradythrips hesperus* Hood & Williams, 1925; KLNP/MU/Lr 8	22.vi.2012 Two	Mycophagous & Dry twigs	India (Kerala, Manipur), Guyana Borneo, South America.
58.	*Coxothrips tarai** (Stannard, 1970); KLNP/MU/Lr 9	14.xi.2012 Two	Mycophagous & litter	India (Manipur, Uttar Pradesh).
59.	*Dexiothrips* (=*Apelaunothrips*) *madrasensis* (Ananthakrishnan, 1964); KLNP/MU/Lr 10	24.ix.2011 Five	Mycophagous & litter	India (Tamil Nadu, Kerala, Manipur), Indonesia, Java, Malaysia.
60.	*Dolichothrips indicus** (Hood, 1919); KLNP/MU/Wd 5	12.ii.2012 Two	Weed; *Albizia myriophylla* Benth. (Fabaceae)	India (Assam, Karnataka, Manipur, Tamil Nadu).
61.	*Dolichothrips malhavii** Ananthakrishnan,1961; KLNP/MU/Wd 6	7.xii.2011 Five	Weed; Leaves of *Albizia myriophylla* Benth (Fabaceae)	India (Agra, Manipur).
62.	*Dolichothrips montanus** Ananthakrishnan, 1964; KLNP/MU/Fl 18	4.viii.2011 Two	Flower; *Lantana camara* Linn. (Verbenaceae)	India (Manipur, Nagaland, West Bengal).

Table 1: Systematic collection record of Thrips of KLNP (*contd.*)

Sl. No.	Name of the species with registration number	Date of collection & No. of specimens studied	Habit, microhabitats & Host plants	Distribution
63.	*Ecacanthothrips tibialis* (Ashmead, 1905); KLNP/MU/Lr 11	12.ii.2010 One	Mycophagous & Dry twigs	India (Kerala, Tamil Nadu, West Bengal, Meghalaya, Tripura, Manipur), Australia, China, Japan, Philippines, Tanzania, Vietnam, Indonesia, Malaysia, New Zealand.
64.	*Eothrips coimbatorensis**@ Ramakrishna, 1928; KLNP/MU/G 2	15.ix.2012 Five	Leaf gall; galls of an unidentified plant	India (Manipur, Tamil Nadu, Rajasthan).
65.	*Gigantothrips elegans* Zimmermann, 1900; KLNP/MU/L 15	12.viii.2011 Two	Leaf; *Ficus glomerata* Roxb. (Moraceae)	India (Widespread), Philippines, Japan, Indonesia, Thailand.
66.	*Gigantothrips ochroscelis**@ Priesner, 1951; KLNP/MU/L 16	26.v.2012 One	Leaf; *Ficus glomerata* Roxb. (Moraceae)	India (Manipur, Tamil Nadu).
67.	*Gigantothrips seshadrii** (Ananthakrishnan, 1964); KLNP/MU/L 17	4.viii.2012 Two	Leaf; *Ficus glomerata* Roxb. (Moraceae)	India (Manipur, Kerala).
68.	*Gynaikothrips bengalensis** Ananthakrishnan, 1973; KLNP/MU/G 3	21.i.2012 Five	Gall; *Ficus religiosa* Linn. (Moraceae)	India (Assam, Manipur, West Bengal).
69.	*Gynaikothrips cecedii** Ananthakrishnan, 1968; KLNP/MU/G 4	22.viii.2012 Four	Gall; *Ficus* sp. (Moraceae)	India (Tamil Nadu, Madhya Pradesh).
70.	*Haplothrips andresi*@ Priesner, 1931; KLNP/MU/L 18	8.ii.2012 Five	Leaf; *Scirpus lacustris* L. (Cyperaceae)	India (Tamil Nadu, Manipur), Egypt, France, Cyprus.
71.	*Haplothrips ceylonicus* Schmutz, 1913; KLNP/MU/Gr 5	14.v.2011 Five	Grass; *Arundo donax* L. (Poaceae), *Ipomea palmata* Forssk. (Convolvulaceae)	India (Tamil Nadu, West Bengal, Manipur, Nagaland), Sri Lanka, Java, Sumatra.
72.	*Haplothrips gowdeyi* (Franklin, 1908); KLNP/MU/Fl 19	28.x.2012 Two	Flower; *Andropogon zizanioides* (Linn.) Urban, *Arundo donax* L., *Bambusa* sp. (Poaceae)	India (Tamil Nadu, Rajasthan, West Bengal, Manipur), China, Japan, Latin America.
73.	*Haplothrips longisetosus**@ Ananthakrishnan, 1955; KLNP/MU/L 19	7.iv.2012 Six	Leaf; *Schoenoplectus lacustris* (L.) Palla (Cyperaceae)	India (Manipur, Kerala, Tamil Nadu).
74.	*Haplothrips tenuipennis* Bagnall, 19l8; KLNP/MU/Fl 20	8.xii.2011 Three	Flower/leaf; *Scirpus lacustris* L. (Cyperaceae) & *Ipomoea palmata* Forssk. (Convolvulaceae)	India (Assam, Maharashtra, Madhya Pradesh, Rajasthan, Tamil Nadu, West Bengal), Bangladesh, China, Indonesia.
75.	*Hoplandrothrips corticis** Ananthakrishnan, 1972; KLNP/MU/Lr 12	21.iii.2013 One	Mycophagous & Dry twigs	India (Manipur, Tamil Nadu).
76.	*Hoplandrothrips flavipes* Bagnall, 1923; KLNP/MU/Lr 13	12.ix.2011 One	Mycophagous & Dry twigs	India (Western Ghats, NE India), Philippines, Brazil, Europe, Kenya, Nigeria, USA (Hawaii), China, Colombia, Solomon Islands, Trinidad, St. Lucia, Venezuela.
77.	*Hoplothrips fungosus* Moulton, 1928; KLNP/MU/Lr 14	22.vi.2012 One	Mycophagous & Dry twigs	India (Tamil Nadu, Karnataka, West Bengal), Japan, China, widespread in east Asia.
78.	*Karnyothrips melaleucus* (Bagnall, 1911); KLNP/MU/Gr 6	8.ix.2011 Six	Grass; *Cymbopogon nardus* (L.) Rendle (Poaceae)	India (Kerala, Manipur, Tamil Nadu), China, Florida, Vietnam, Denmark, Indonesia.

Table 1: Systematic collection record of Thrips of KLNP (*contd.*)

Sl. No.	Name of the species with registration number	Date of collection & No. of specimens studied	Habit, microhabitats & Host plants	Distribution
79.	*Karnyothrips mucidus** (Ananthakrishnan & Jagadish, 1971); KLNP/MU/Lr 15	3.vii.2012 One	Mycophagous & Dry twigs	India (Kerala, Manipur, West Bengal).
80.	*Leeuwenia ananthakrishnani*** Varatharajan & Sen, 2000; KLNP/MU/L 20	24.ii.2012 Seven	Leaf; *Quercus serrata* Thunb. (Fagaceae)	India (Manipur, Nagaland).
81.	*Leeuwenia eugeniae**@ Bagnall, 1924; KLNP/MU/L 21	24.ii.2011 Six	Leaf; *Eugenia jambolana* Lam. (Myrtaceae)	India (Manipur, Tamil Nadu, Arunachal Pradesh).
82.	*Leeuwenia maculans** Priesner & Seshadri, 1953; KLNP/MU/Lr 15	24.ii.2012 One	Leaf; *Eugenia jambolana* Lam. (Myrtaceae)	India (Manipur, Tamil Nadu).
83.	*Liophloeothrips pavettae** Ananthakrishnan & Jagadish, 1969; KLNP/MU/G 3	16.viii.2012 Two	Gall; *Pavetta* sp. (Rubiaceae)	India (Andhra Pradesh, Manipur).
84.	*Liophloeothrips segnis** Ananthakrishnan & Jagadish, 1969; KLNP/MU/G 4	4.xi.2011 Two	Gall; galls of an unidentified plant	India (Karnataka, Manipur).
85.	*Liothrips aberrans** Muraleedharan & Sen, 1978; KLNP/MU/G 5	21.iv.2012 Three	Gall; gall of *Bixa orellana* Linn. (Bixaceae)	India (Manipur, West Bengal, Sikkim).
86.	*Liothrips aequilus*@* Ananthakrishnan & Jagadish, 1969; KLNP/MU/G 6	26.v.2012 Two	Gall; *Eugenia jambolana* Lam. (Myrtaceae)	India (Andhra Pradesh, Nagaland).
87.	*Liothrips bournieri*** Sen, 1984; KLNP/MU/G 7	21.xii.2012 Three	Gall; *Quercus* sp. (Fagaceae)	India (Manipur, Tripura).
88.	*Liothrips himalayanus** Ananthakrishnan & Jagadish, 1970; KLNP/MU/G 8	4.viii.2012 Four	Gall; *Quercus serrata* Thunb. (Fagaceae)	India (Darjeeling, Manipur, Nagaland).
89.	*Liothrips* (*Liothrips*) *litseae* Moulton, 1933; KLNP/MU/G 9	18.iii.2011 Five	Gall; Gall of unknown plant	India (Eastern Ghats, Manipur), Japan.
90.	*Liothrips mohanrami*** Bhatti, Varatharajan & Singh, 2006; KLNP/MU/G 10	4.ix.2012 Two	Gall; Gall of unknown plant	India (Manipur, Nagaland).
91.	*Margaritothrips sumatrensis*@ Priesner, 1932; KLNP/MU/Lr 16	4.ix.2011 Two	Mycophagous & Dry twigs	India (Kerala, Meghalaya, Tamil Nadu), Sumatra, Indonesia.
92.	*Mesothrips extensivus** Ananthakrishnan & Jagadish, 1969; KLNP/MU/L 22	21.x.2012 Three	Leaf; *Quercus serrata* Thunb. (Fagaceae)	India (Eastern & Western Ghats, Assam, Meghalaya, Manipur).
93.	*Mesothrips latus*** Muraleedharan & Sen, 1981; KLNP/MU/L 23	5.x.2012 Four	Leaf; *Quercus serrata* Thunb. (Fagaceae)	India (Manipur, Tripura).
94.	*Mystrothrips dammermani* (Priesner, 1933); KLNP/MU/Lr 17	4.ix.2011 Two	Mycophagous & litter	India (Karnataka, Manipur, Tamil Nadu), Egypt, Indonesia.
95.	*Ocnothrips indicus** Ananthakrishnan, 1969; KLNP/MU/G 11	5.x.2012 One	Gall; *Quercus* sp. (Fagaceae)	India (Manipur, Western Ghats).
96.	*Phlaeothrips nilgiricus**@ Ananthakrishnan, 1968; KLNP/MU/G 12	14.vi.2012 Four	Gall; galls of an unidentified plant	India (Manipur, Tamil Nadu).

Table 1: Systematic collection record of Thrips of KLNP (*contd.*)

Sl. No.	Name of the species with registration number	Date of collection & No. of specimens studied	Habit, microhabitats & Host plants	Distribution
97.	*Plicothrips apicalis**@ (Bagnall, 1915); KLNP/MU/Gr 7	14.ix.2011 One	Grass; *Cynodon dactylon* (L.) Pers. (Poaceae)	India (Almora, Kumaon, Manipur).
98.	*Podothrips scitulus**@ Ananthakrishnan, 1967; KLNP/MU/Gr 8	14.vii.2011 Four	Grass; *Cymbopogon nardus* (L.) Rendle & *Saccharum munja* Roxb. (Poaceae)	India (Manipur, Tamil Nadu).
99.	*Praepodothrips indicus** Priesner & Seshadri, 1952; KLNP/MU/L 24	21.v.2012 Two	Leaf; *Pinus kesiya* Royle ex. Gordon (Pinaceae)	India (Manipur, Tamil Nadu).
100.	*Praepodothrips priesneri** Ananthakrishnan, 1955; KLNP/MU/Gr 9	21.v.2012 Five	Grass; *Bambusa* sp. (Poaceae)	India (Manipur, Tamil Nadu).
101.	*Sophiothrips nigrus* (Ananthakrishnan, 1971); KLNP/MU/Lr 18	6.iv.2012 One	Mycophagous & litter	India (Manipur, West Bengal), China, Japan, Singapore, Malaysia, Indonesia.
102.	*Stigmothrips consimilis*@ Ananthakrishnan, 1969; KLNP/MU/Lr 19	5.xi.2011 Four	Mycophagous & litter	India (Karnataka, Kerala, Manipur), Japan.
103.	*Adraneothrips* (=*Stigmothrips*) *infirmus* (Ananthakrishnan, 1971); KLNP/MU/Lr 20	12.iii.2012 Four	Mycophagous & litter	India (West Bengal, NE India), Japan.
104.	*Adraneothrips* (=*Stigmothrips*) *okajimai*** (Muraleedharan & Sen, 1981); KLNP/MU/Lr 21	4.x.2012 Two	Mycophagous & Litter	India (Meghalaya, Manipur, Tripura).
105.	*Thlibothrips manipurensis*** Muraleedharan, 1982; KLNP/MU/G 13	8.ix.2012 Two	Gall; *Quercus* sp. (Fagaceae)	India (Manipur).
106.	*Tylothrips indicus*** Sen & Muraleedharan, 1976; KLNP/MU/L 25	21.vii.2012 One	Leaf; an unidentified wild plant	North East region of India.
107.	*Xylaplothrips inquilinus*@ (Priesner, 1921); KLNP/MU/G 14	22.xii.2012 Three	Gall; *Pavetta sp.* (Rubiaceae)	India (Kerala, Andhra Pradesh, Tamil Nadu), Indonesia.
108.	*Xylaplothrips pusillus** Ananth. & Jagadish, 1969; KLNP/MU/Lr 22	8.iv.2012 Two	Mycophagous & litter	India (Andhra Pradesh, Kerala, Manipur, West Bengal).
109.	*Xylaplothrips tener** Ananth. & Jagadish, 1969; KLNP/MU/Lr 23	23.iii.2012 One	Mycophagous & litter	India (Andhra Pradesh, Kerala, Manipur).
	Family: Phlaeothripidae; Subfamily: Idolothripinae (Mycophagous)			
110.	*Acallurothrips* (=*Pygothrips*) *amplus* (Faure, 1949); KLNP/MU/Lr 24	5.ix.2011 Two	Mycophagous & dry twigs	India (Manipur, Tamil Nadu), South Africa.
111.	*Elaphrothrips curvipes* Priesner, 1929; KLNP/MU/Lr 25	14.ix.2011 Seven	Mycophagous & dry twigs	India (Manipur, Meghalaya, West Bengal), Sumatra, Thailand.
112.	*Elaphrothrips denticollis* (Bagnall, 1909); KLNP/MU/Lr 26	14.ix.2011 Three	Mycophagous & dry leaves	India (Kerala, Tamil Nadu, Karnataka, Tripura), Myanmar, Malaysia, Indonesia.
113.	*Elaphrothrips insignis** Ananthakrishnan, 1973; KLNP/MU/Lr 27	21.viii.2012 Two	Mycophagous & dry twigs	India (Manipur, Uttar Pradesh).
114.	*Holurothrips manipurensis*** Varatharajan & Chochong, 2004; KLNP/MU/Lr 28	7.x.2011 Five	Mycophagous & litter	India (Manipur).

Table 1: Systematic collection record of Thrips of KLNP (*contd.*)

Sl. No.	Name of the species with registration number	Date of collection & No. of specimens studied	Habit, microhabitats & Host plants	Distribution
115.	*Machatothrips indicus**@ Ananthakrishnan & Jagadish, 1970; KLNP/MU/Lr 29	12.iii.2011 Two	Mycophagous & litter	India (Kerala, Manipur).
116.	*Meiothrips menoni** Ananthakrishnan, 1964; KLNP/MU/Lr 30	5.xii.2012 One	Mycophagous & litter	India (Kerala, Manipur).
117.	*Meiothrips nepalensis* Kudo & Ananthakrishnan, 1974; KLNP/MU/Lr 31	12.vi.2012 One	Mycophagous & litter	India (Manipur and Nagaland), Nepal, Thailand.
118.	*Nesidiothrips alius** (Ananthakrishnan, 1970); KLNP/MU/Lr 32	5.iii.2012 Nine	Mycophagous & dry twigs	India (Kerala, Manipur).
119.	*Nesothrips brevicollis* (Bagnall, 1914); KLNP/MU/Lr 33	2.ii.2011 Nine	Mycophagous & dry twigs	India (Kerala, Madhya Pradesh), China (Taiwan), Japan, Indonesia, Mauritius, USA (Hawaii).

* indicates species endemic to India; ** endemic to NE India; @New record for Manipur.

thrips occurring on dry twigs, 17 gall thrips, 10 grass dwellers, 7 pests, 5 weed infesting forms, 2 predatory thrips and an aquatic form. Among the total number of species, 25% are mycophagous, 73.5% associate with flowering plants, and only 1.5% are predatory.

DISCUSSION

The world fauna indicates that 60% of known tubuliferans are mycophagous (Mound 2005), while in the present study only 46% of phlaeothripids were mycophagous, of which 10 species belonging to subfamily Idolothripinae exclusively fed on spores, while the rest fed on mycelia and fungal hyphae. Individuals of the above two subfamilies – Phlaeothripinae and Idolothripinae can be distinguished by their stylets: the stylets of idolothripines are slightly thicker and band-like (5–10 µm diameter) to enable them to feed on spores, while phlaeothripines have slender maxillary stylets with a diameter of 1–3 µm (Mound 1974). The survey revealed the dominance of phytophagous species over mycophagous species. However, this ratio may change with the collection of more individuals. Thrips that are denoted as pest are based on the available record with the author, especially under the climatic conditions of NE India (Varatharajan 2005). It is also significant to note that thrips have been collected from plant hosts of about 86 species belonging to 30 different families; families Poaceae, Fagaceae, Fabaceae, Asteraceae, and Convolvulaceae are worth mentioning as they harbour at least a dozen thrips species each. Although many thrips species show association with plants of diverse families, it is difficult to pinpoint their plant hosts, with the exception of certain pests and gall thrips. Most of the phytophagous species are either polyphagous or oligophagous, feeding on a variety of plants. For instance, *Stenchaetothrips biformis*, *Sciothrips cardamomi*, and *Panchaetothrips indicus* have restricted hosts such as paddy, cardamom, and turmeric plants respectively. Similarly, *Leeuwenia eugeniae*, *Leeuwenia ananthakrishnani*, and *Gigantothrips elegans* infest Eugenia, Oak, and Ficus respectively. Likewise the gall thrips *Thlibothrips manipurensis* makes a marginal roll on *Ardisia* sp. and *Athlibothrips inquilinus* on *Bixa orellana*, exemplifying a narrow host range. On the other hand, the cosmopolitan pests like *Anaphothrips sudanensis*, *Thrips tabaci*, *Thrips palmi*, and *Scirtothrips dorsalis* have a wide range of hosts. This view is in tune with that of Mound (2011) who has noted nearly 9,000 species of grasses supporting 300 species of thrips. Therefore, based on the present study, it appears that the common families namely Poaceae, Asteraceae, Fabaceae mentioned above appear to accommodate an appreciably large number of species.

Mycterothrips auratus Wang, 1999

Mycterothrips auratus Wang, 1999 has been reported earlier from Taiwan (Masumoto and Okajima 2006) and

China (Mirab-Balou *et al.* 2011). In Manipur, the species was collected from the Keibul Lamjao National Park (24° 27′–24° 31′ N; 93° 53′–93° 55′ E; 767–788 m above msl).

1999. *Mycterothrips auratus*: Wang, *Chinese Journal of Entomology 19*: 229–238
2006. *Mycterothrips auratus*: Masumoto & Okajima, *Zootaxa. 1261*: 1–90

Diagnostic characters: Body uniformly yellowish brown. Head with cheeks straight. Rows of microtrichia on the antennal segment II. Male with antennal segment VI much longer than that of female. Pronotum with about 50 discal setae. A pair of median setae placed near the posterior margin on the mesonotum. Metascutum with a pair of median setae near the anterior margin, close to the submedian setae. Abdominal terga II to VII with numerous microtrichia along the lines of sculpture. Abdominal terga with B4 setae minute gradually. Total body length: 1721; Length of antennal segments (width) I: 37–39(49–50), II : 53–55(31–32), III: 52–53(31–34), IV: 37–41(36–37), V:16–21(32), VI: 356–367(41–46), VII: 6–8(7) and VIII: 13(6–7); Head length: 48.3, width across eyes: 64; width across cheeks: 67; Length of Ocellar setae I: 28–29, II: 26–27, III: 70–77 and distance between ocellar setae: 39–41; Pronotum length (width): 44(69). Inner post angular setae: 98–99; Outer post angular setae: 82; Fore wing length (width across the middle): 411–420(58–59). Length of abdominal segments (width) VII: 88(221), VIII: 90(183), IX: 58(131) and X: 49(98) (all the measurements are in micrometres) (Fig. 1).

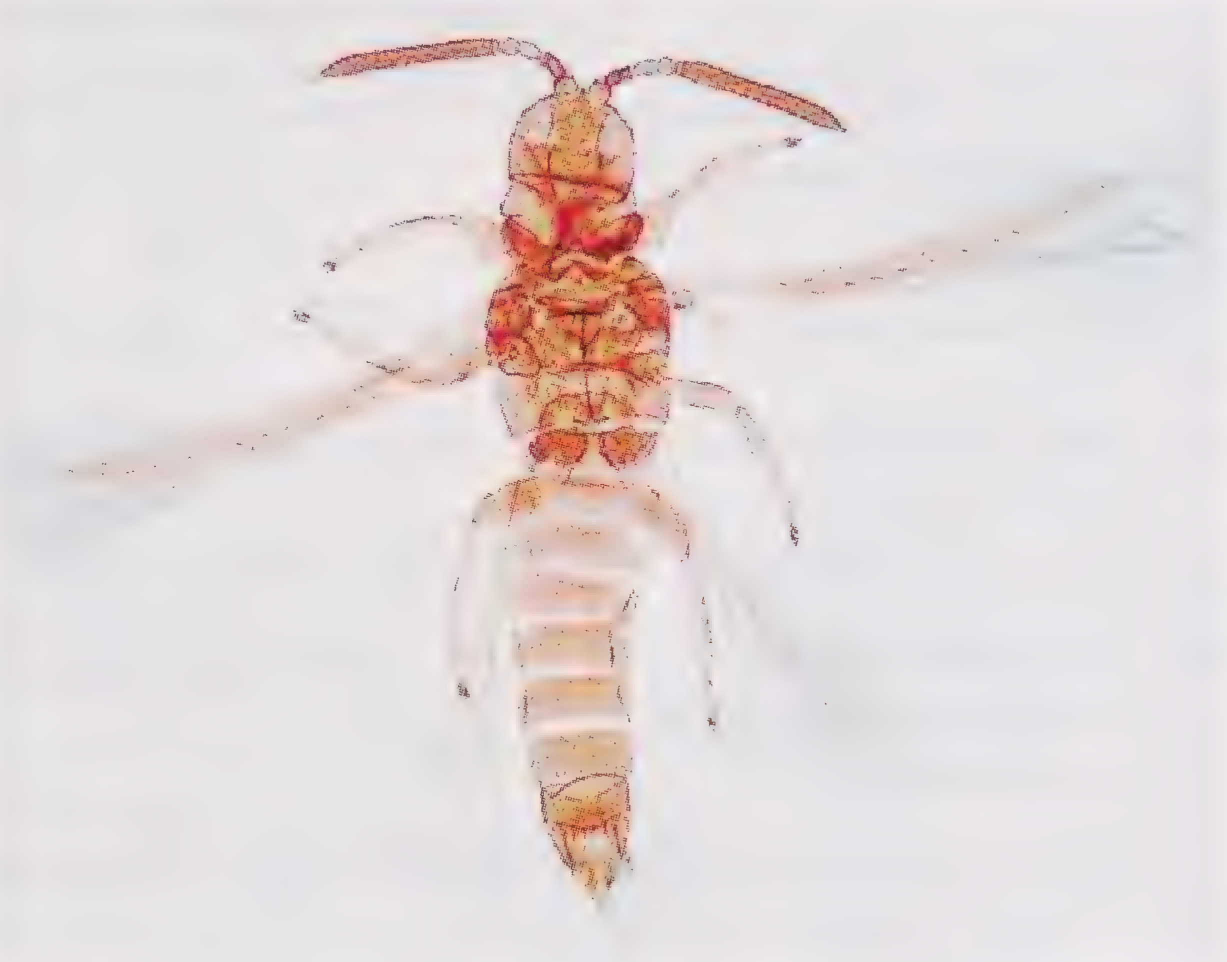
Fig. 1: Whole mount of *Mycterothrips auratus* Wang, 1999

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AEROBIC CULTURABLE BACTERIAL MICROFLORA IN RESIDENT *GYPS* VULTURE SPECIES OF INDIA

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Microflora of three Critically Endangered, resident *Gyps* species of Indian vultures was studied at the Vulture Conservation Breeding Centre, Pinjore, Panchkula district, Haryana. Cloacal and choanal swabs from 32 adult *Gyps* vultures (10 White-rumped *Gyps bengalensis*, 11 Long-billed *G. indicus* and 11 Slender-billed *G. tenuirostris*) held in captivity at the centre were collected in October 2011 and analyzed to determine the presence of aerobic culturable bacteria. A total of 23 bacterial species were isolated from the 64 cloacal and choanal samples collected and analyzed. The commonly encountered bacteria in the gastrointestinal tract were *Escherichia coli*, *Enterococcus faecalis*, and *Enterococcus avium*, while *Staphylococcus epidermidis*, *S. saprophyticus*, and *Streptococcus pneumoniae* were prevalent in the respiratory tract. The rest of the bacterial species were of low prevalence, and no specific pattern of colonization was seen. In spite of their exposure to a variety of microorganisms due to the scavenging nature of the vultures, only a few organisms were observed to colonize successfully and form the normal flora. The bacterial species richness and diversity among the three vulture species was similar.

Key words: Gastrointestinal, respiratory, aerobic culturable bacteria, *Gyps* vultures, conservation, Critically Endangered

INTRODUCTION

In animals, the microflora of an individual plays a vital role in the normal physiological functions. The communities of microorganisms established in the gut of an individual have been shown to be essential for its metabolic activities (Apajalahti 2005). The microflora of humans has been extensively studied, and the individual's gut microflora composition has been linked to the diet (Benno *et al.* 1989; Muegge *et al.* 2011). It has also been shown that the patterns of gut microflora deviate considerably from normal in certain disease conditions, such as ulcerative colitis (Hartley *et al.* 1992).

As obligate scavengers, vultures provide important ecosystem services by feeding on dead animals, thus limiting the multiplication and spread of pathogens present in carcasses, thereby limiting disease in livestock and humans. The population of three resident *Gyps* species of India – White-rumped Vulture *Gyps bengalensis*, Long-billed Vulture *G. indicus*, and Slender-billed Vulture *G. tenuirostris* – has declined by over 99% in the past two decades due to diclofenac contamination of domesticated animal carcasses (Green *et al.* 2004; Oaks *et al.* 2004; Prakash *et al.* 2012). To prevent the possible extinction of these species, a conservation breeding programme was initiated in India by the Ministry of Environment and Forests, Government of India, in collaboration with the Bombay Natural History Society and Haryana Forest Department. The first Vulture Conservation Breeding Centre was established at Pinjore, Haryana. Individuals of the three species were caught from the wild to establish a founder population. These species were rarely kept in captivity earlier, and hence information on various aspects of their health and disease is lacking.

Nothing is known about the prevalence of microflora in these three Critically Endangered species of Indian *Gyps* vultures. The microflora of some vulture species has been studied in other parts of the world: Turkey Vulture *Cathartes aura* in North America (Winsor *et al.* 1981); American Black Vulture *Coragyps atratus* in South America (Rodrigues *et al.* 2003); Eurasian Griffon Vulture *Gyps fulvus* (Kocijan *et al.* 2009); and Egyptian Vulture *Neophron percnopterus* (Blanco *et al.* 2007) in Europe. The microflora of other raptor species has also been studied (Bangert *et al.* 1988; Blanco *et al.* 2006). These studies reported that species richness and diversity of gram positive bacteria was comparatively less than gram negative bacteria in the gastrointestinal tract. Some of these studies discussed the impact of variations in the diet of birds on the microflora composition in captive or wild birds (Bangert *et al.* 1988; Blanco *et al.* 2006). Another study showed the effects of geographical variations on the microflora and their antibiotic resistance properties (Blanco *et al.* 2007). The general pattern that emerged from these studies was that the diet of a raptor plays a major role in determining the gastrointestinal tract microflora.

The majority of the studies mentioned above collected faecal samples to study the gut microflora (Bangert *et al.* 1988; Kocijan *et al.* 2009; Rodrigues *et al.* 2003). However, some other studies such as Blanco *et al.* (2007) on Egyptian Vulture and Lombardo *et al.* (1996) on Tree Swallow *Tachycineta bicolor* also worked with cloacal samples. The bacterial microflora in the respiratory system has not been studied before in vulture species, and has been studied to a limited extent in other raptors, such as Peregrine Falcon *Falco peregrinus* using choanal samples (Cooper *et al.* 1980). Several studies have reported a significant difference between the microflora of wild and captive animals of the same species (Ley *et al.* 2008; Nelson *et al.* 2013; Scupham *et al.* 2008; Uenishi *et al.* 2007; Villers *et al.* 2008; Wienemann *et al.* 2011; Xenoulis *et al.* 2010). The authors of these studies concluded that these differences in microflora existed between animals born in the wild and those born in captivity.

In this paper, we report the aerobic culturable bacteria recorded in three resident species of wild-caught, captive vultures at the Vulture Conservation Breeding Centre, Pinjore. The findings of this study, besides being the first to document the microflora of *Gyps* vultures in India, could be used as a benchmark to detect deviations from the normal, which could reflect on health issues for these and similar species.

MATERIAL AND METHODS

Study Animals

The vultures from which the samples were collected were housed at the Vulture Conservation Breeding Centre (VCBC), Pinjore, Haryana. VCBC falls within the normal distribution range of all the three species studied (Ali and Ripley 1983). The vultures are kept in flocks in near natural conditions in large aviaries (30.48 x 12.19 x 6.10 m). They are fed on entire skinned goat carcasses. The diet of the wild *Gyps* vultures consists almost exclusively of carrion, and *Gyps* vultures are especially adapted to consume the soft tissues such as muscle and internal organs of animal carcasses (Ali and Ripley 1983).

All the birds sampled were caught from the wild in different parts of India, including the northern states of Haryana and Delhi, the western states of Maharashtra, Gujarat, and Rajasthan, the north-eastern state of Assam, and Madhya Pradesh in central India. The vultures had been in captivity for two or three years at the time of sampling. All the sampled birds were adults and chosen at random for the sampling.

Processing of samples for isolation and identification of bacteria

Cloacal swab samples were collected during October 2011 to investigate the gastrointestinal bacteria, and choanal samples to study the upper respiratory tract bacteria. Such samples were taken from 10 randomly selected White-rumped, 11 Long-billed, and 11 Slender-billed vultures. Two cloacal and choanal samples were taken from each bird and analyzed simultaneously. The swabs were inoculated in soybean casein digest broth to enrich the bacteria present in the sample. 10 µl of the overnight culture from both the sets was then used to streak onto nutrient agar plates, so as to get isolated colonies of all the enriched bacteria. These streaked plates were used to observe different colony types on the basis of their colony characters. The different colony types were isolated for further identification. The method for the enrichment and isolation of different bacterial species was standard microbiological procedure similar to that followed for studying the faecal bacteria in raptors (Bangert *et al.* 1988), Red Kite *Milvus milvus* (Blanco *et al.* 2006), and Eurasian Griffon (Kocijan *et al.* 2009). Preliminary tests for identification of bacterial genera and secondary biochemical tests for identification of species were carried out using traditional culture based methods and biochemical tests following standard literature (Holt 1984, 1986; Quinn *et al.* 1994). The secondary biochemical tests employed for the genus and species identification of the isolates are summarized in Table 1.

Results from these tests were fed into an online bacterial identification system called ABIS (www.tgw1916.net). The identification results using the above mentioned software are comparable with the results obtained using the Bergey's Manual of Systematic Bacteriology, Vols 1 and 2, and Clinical Veterinary Microbiology, Quinn and Carter. Isolates requiring further confirmation for identification of species were sent for 16s rRNA sequencing service provided by SciGenom Labs, Pune, Maharashtra, India.

Analysis

Bacteria are known to occupy a certain niche, and live commensally with the host. However, they could

Table 1: Summary of biochemical tests used for species level identification

Group of organisms	Tests applied
Gram negative rods and coccobacilli	Fermentation of sugars glucose, sucrose, maltose, mannitol, xylose, trehalose, and lactose, growth on MacConkey's agar and EMB agar, Oxidase, Nitrate test, Indole test, MR test, VP test, Citrate utilization test, Urease test, growth on TSI agar to check for H_2S production.
Gram positive catalase positive cocci	Haemolysis on sheep blood agar, slide coagulase, tube coagulase, growth at 6.5% NaCl, DNase, TNase, Phosphatase, Resistance to Novobiocin, fermentation of sugars mannitol and trehalose.
Gram positive catalase negative cocci	Haemolysis on sheep blood agar, fermentation of esculin, bile tolerance, growth at 6.5% NaCl, hydrolysis of hippurate, resistance to Bacitracin, fermentation of sugars lactose, mannitol, trehalose, sorbitol, and raffinose.
Gram positive rods	Presence of endospores, presence of volutin granules, motility in semi-solid medium, nitrate reduction test and colony morphology.

be pathogenic when in a different niche within the same host. For example, *Escherichia coli* normally inhabits the gastrointestinal system, but could turn into a pathogen when in the respiratory system. Comparison of the prevalence patterns of the bacterial groups in the gastrointestinal and respiratory tracts could give an idea of any abnormal prevalence. Hence, all the bacterial species isolated (13 from gastrointestinal tract and 10 from respiratory tract) were grouped into five families according to their biochemical characteristics: Enterobacteriaceae, Enterococcaceae, Streptococcaceae, Staphylococcaceae, and Bacillaceae, and the differences in the microflora among the vulture species were analyzed by the same statistical tests. The prevalence patterns of the bacterial groups were tested by the Mann-Whitney *U* test through the lacostatistical software GraphPad Prism version 5. Prior to the grouping into families, the differences in the bacterial diversities among the three vulture species were assessed by the Kruskal-Wallis test and its post-tests (Dunn's Multiple Comparison tests).

RESULTS

Bacterial species in gastrointestinal and respiratory tracts

A total of 13 and 10 bacterial species were isolated from the gastrointestinal (Table 2) and respiratory (Table 3) tracts for all the three vulture species. The bacterial species richness and diversity across the gastrointestinal tracts and the respiratory tracts between the three vulture species were similar ($p > 0.05$, Kruskal-Wallis test). While determining the habitat specificity of the bacteria, it was found that bacteria of the family Enterobacteriaceae was more prevalent in the gastrointestinal tract ($p=0.01$, Mann-Whitney *U* test), whereas Staphylococcaceae was more prevalent in the respiratory tract ($p=0.032$, Mann-Whitney *U* test). No difference was observed in the prevalence of Enterococcaceae, Streptococcaceae, and Bacillaceae between the gastrointestinal and respiratory tract samples ($p > 0.05$, Mann-Whitney *U* test).

DISCUSSION

Bacterial microflora in the gastrointestinal tract

Escherichia coli was the most prevalent bacterial species in the gastrointestinal tract of all the three vulture species, followed by the enterococcal species *Enterococcus faecalis* and *E. avium*. This is similar to the findings on Eurasian Griffon (Kocijan *et al.* 2009), American Black Vulture (Rodrigues *et al.* 2003), Turkey Vulture (Winsor *et al.* 1981), Red Kite (Blanco *et al.* 2006), and raptors of Falconiformes and Strigiformes (Bangert *et al.* 1988). These bacterial species are also of common occurrence in the gastrointestinal system of humans and a variety of animals, and are responsible for metabolism of carbohydrates to generate energy, production of Vitamin K, immuno-stimulation, creation of anaerobic conditions to facilitate succession by strict anaerobes and outcompeting pathogens (Silva *et al.* 2011). These bacteria are most likely to be contributors to the normal gut microflora of these vulture species.

Houston and Cooper (1975) had studied the digestive tract of the White-backed Vulture *Gyps africanus*, and had reported that the high acidity of the digestive environment (a pH range as low as 1–2) effectively eliminates most of the pathogenic bacteria found in rotting animal carcasses, including *Bacillus anthracis*. This is also possibly the reason for the low diversity of bacteria recorded by us in Indian *Gyps* vultures. They had suggested that *Escherichia coli* colonize the gut at a very early stage of growth, when the high acidic condition has not developed.

The majority of bacteria isolated in the gastrointestinal tract samples are indicative of the feeding habits of the birds,

Table 2: Prevalence of bacterial microflora in the gastrointestinal tract of three *Gyps* vultures

	Bacterial species	**Vulture species**		
		White-rumped (n=10)	**Long-billed (n=11)**	**Slender-billed (n=11)**
Bacillaceae	*Bacillus cereus*	30%	27%	9%
	Bacillus subtilis	0%	0%	9%
Enterobacteriaceae	*Escherichia coli*	90%	91%	91%
	Edwardsiella tarda	10%	9%	0%
	Enterobacter asburiae	0%	9%	0%
	Salmonella enterica	10%	9%	9%
Enterococcaceae	*Enterococcus avium*	30%	36%	36%
	Enterococcus faecalis	50%	36%	36%
Streptococcaceae	*Streptococcus adjacens*	10%	0%	0%
	Streptococcus pneumoniae	10%	9%	0%
Staphylococcaceae	*Staphylococcus epidermidis*	20%	9%	18%
	Staphylococcus haemolyticus	10%	0%	0%
	Staphylococcus saprophyticus	10%	0%	9%

Note: The values represent the percentage of birds tested positive for the bacterial species with one sample per bird.

Table 3: Prevalence of bacterial microflora in the respiratory tract of three *Gyps* vultures

	Bacterial species	**Vulture species**		
		White-rumped (n=10)	**Long-billed (n=11)**	**Slender-billed (n= 11)**
Bacillaceae	*Bacillus cereus*	20%	36%	45%
Enterobacteriaceae	*Escherichia coli*	60%	45%	36%
	Escherichia fergusonii	20%	18%	27%
	Salmonella enterica	10%	0%	0%
Streptococcaceae	*Streptococcus pneumoniae*	0%	45%	27%
Enterococcaceae	*Enterococcus avium*	40%	27%	18%
	Enterococcus durans	10%	18%	27%
Staphylococcaceae	*Staphylococcus pseudintermedius*	10%	0%	0%
	Staphylococcus epidermidis	20%	45%	27%
	Staphylococcus saprophyticus	40%	54%	27%

Note: The values represent the percentage of birds tested positive for the bacterial species with one sample per bird.

as these are found in a variety of animals, including goats and sheep that form the food source of the vultures at our Centre. *Edwardsiella tarda* recorded during this study could also have been obtained through water. This bacteria is a widely reported fish pathogen (Park *et al.* 2012), but is also an opportunistic human pathogen and an agent of zoonosis (Janda *et al.* 1991; John *et al.* 2012; Slaven *et al.* 2001). One bird each of White-rumped and Long-billed Vultures recorded carrying this bacterium did not exhibit symptoms of disease, indicating that the organism was unable to colonize and induce pathogenicity.

Bacillus cereus was found in 22% of the cloacal samples, while *Salmonella enterica*, *Edwardsiella tarda*, *Bacillus subtilis*, and *Staphylococcus haemolyticus* were obtained at low frequencies from a small number of samples. No clear trend in the prevalence patterns of these bacterial species was observed, and they probably represent transient flora obtained through food, water, or the environment.

Bacillus spp. cannot survive in the highly acidic conditions which prevail in vulture gastrointestinal tract, and would have mostly come as spores through goat and sheep meat. They are opportunistic pathogens that can infect immuno-compromised hosts. The lack of any clinical symptoms in the host vultures carrying these organisms confirms that they were unable to proliferate and express any pathogenicity.

Bacterial microflora in the respiratory tract

The high prevalence of *Escherichia coli* recorded in all three species of vultures, not considered a normal component of the microflora of the respiratory environment (Gingerich 2011), suggests the possibility of cross colonization of bacteria through the various routes of bacterial transmission including the faeco-oral route from one vulture to another. As these organisms are eliminated from the respiratory tract by the action of ciliated epithelial cells lining the respiratory tract (Gingerich 2011), the absence of any symptoms in the birds carrying these organisms indicates that these could be transient flora. It would be interesting to check the degree of colonization, if any, of the respiratory tract by organisms of this group. Considerable overlap was also observed in the prevalence patterns of the bacterial groups Enterococcaceae, Streptococcaceae, and Bacillaceae in the gastrointestinal and the respiratory tract. Organisms from the group Staphylococcaceae, especially *Staphylococcus epidermidis* and *S. saprophyticus* were found to be common in the respiratory environment, and are likely members of the normal flora of the respiratory tract. These organisms are able to colonize the respiratory tract on account of its almost neutral pH (range 7.2–7.4, compared to pH 1–2 in the gastrointestinal tract). Also, these organisms colonize the respiratory tract at an early stage on account of their tissue specificity and out-compete the other bacterial groups for binding sites (Todar 2008). Thus, their major role in the respiratory tract is the prevention of pathogens from the environment from colonizing the respiratory tract. Apart from these common staphylococci, an opportunistic pathogen *Staphylococcus pseudintermedius,* was obtained from the choanal sample of a White-rumped Vulture. The identity of this isolate was confirmed through sequencing of the 16s rRNA gene. This organism was discovered from clinical and necropsy isolates from a horse, dog, cat, and parrot by Devriese *et al.* in 2005. However, the role of this organism in causing pathogenicity was not clear. The vulture from which this organism was isolated was healthy and exhibited no apparent symptoms of infection. This is the first reported incidence of the presence of this organism in vultures.

Comparison of gastrointestinal and respiratory tract bacteria

There were no differences in the bacterial prevalence patterns in the cloacal and choanal samples among the three *Gyps* species of vultures. Although the three vulture species are congeneric, they exhibit certain differences in their ecology and feeding patterns in captivity. Thus, it could be concluded that these ecological and feeding differences do not lead to a significant variation in their microflora.

CONCLUSIONS

The study has provided baseline information on the bacterial microflora composition in the gastrointestinal and respiratory tracts of three resident *Gyps* species of vultures of India. The findings may be of help in detecting abnormal occurrence of potential pathogens. Bacterial microflora reported as normal flora in various taxa was also recorded in the vultures during the study. The vulture species in this study are grouped in flocks of 30–35 birds housed in aviaries, which represents a high density of birds per unit area, considering that all their routine activities, including feeding, take place in this limited space. This could be the reason for the high prevalence of enterobacteria in the respiratory tract of the vultures. Microflora examined from four free-ranging Red-headed Vultures *Sarcogyps calvus* has indicated lower prevalence of *Escherichia coli* and Enterobacteriaceae in general, in the choanal samples (R. Shringarpure, unpublished data). These findings may reflect differences between free ranging and captive birds. Future studies on vultures of the same species from both natural and captive environments need to be carried out to substantiate these findings.

Pathogens were rarely encountered and were not observed to express pathogenicity in the host, as all the studied vultures were healthy. Thus, it could be said that the present captive management strategies have not significantly altered the microflora of the captive vultures hatched in the wild. The conservation status of these vultures makes it very difficult to capture wild birds purely for research purposes. However, questions arising from this study have provided a rationale to expand research on these free-ranging vultures. Such a study could identify the cause of deviations from normal microflora in captive birds and develop strategies to ensure that the birds remain healthy and are fit for reintroduction in the wild.

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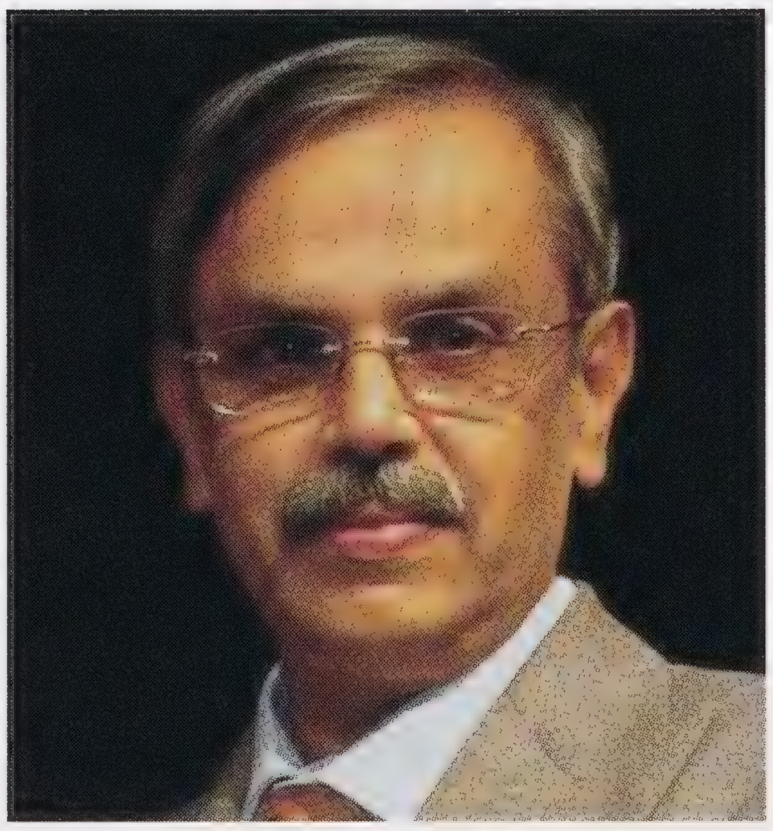
■ ■ ■

OBITUARY

T.C. Narendran

(1944–2013)



Prof. T.C. Narendran, a distinguished entomologist, has left behind a remarkable legacy in the field of insect taxonomy. During his 44 years of teaching and research at the Department of Zoology, University of Calicut, Kerala, India, he was completely dedicated to his work. He has made outstanding contributions to the development of taxonomy, a largely neglected field in our country. His systematic thinking, scientific approach, and time management were an inspiration to his colleagues and students. A man of impeccable integrity, he inspired many to pursue entomological research in India.

Thekke Curuppathe Narendran was born on February 24, 1944, in Trichur district in Kerala state, as the son of an agricultural scientist, Ramanuja Menon. He obtained his Bachelor's degree in Zoology from Kerala University in 1965, and Master's degree from St. John's College, Agra University, Uttar Pradesh in 1967. After obtaining his Master's degree he started his career as a Zoology teacher at St. Aloysius College, in his native town. He started his research as a Research officer at Calicut University in a project dealing with the study of the biology and systematics of Oriental *Brachymeria* (1969–1972). He continued his interest in insect systematics, and for his studies on biology, morphology, and host-parasite relationships of *Brachymeria lasus* (Walker), under the guidance of K.J. Joseph, Calicut University awarded him a Doctorate degree in 1975. In the same year, he joined as a lecturer in the University of Calicut and pursued his passion by teaching insect diversity, morphology, and insect systematics, and principles of taxonomy to postgraduate students and research scholars. Simultaneously, he continued his research on parasitic wasps and made a long-lasting contribution to the field of Chalcid systematics through a number of landmark publications.

He advanced his knowledge and experience in the field by becoming a postdoctoral fellow at the British Natural History Museum, London (1980). During his stay in London, he was fortunate to have collaborated with many experts in the field, especially Z. Boucek, who is considered to be the father of Modern Chalcidology. Later, he visited the US National Museum of Natural History and worked in collaboration with the world-renowned Eurytomid expert Eric E. Grissell. In addition, he collaborated with many scientists in India and abroad through discussions, exchanging type specimens, and so on. Some significant contacts were between him and Mohammad Hayat (Aligarh Muslim University); John S. Noyes (Natural History Museum, London); Kees van Achterberg (National Museum of Natural History, Leiden); Antonius van Harten and Lotfalizadeh (Iran).

His research on insect systematics was funded by a number of agencies that facilitated him to study many agriculturally important parasitic wasps of the families Eurytomidae, Torymidae, and Eulophidae. He continued his research more intensively after his retirement in 2004 in collaboration with M. Nasser, Associate Professor, Department of Zoology, University of Calicut, on the biology and taxonomy of Chalcidoids of the rice ecosystem and biosystematics of Eupelmidae of the Southern Western Ghats (2006–2009). In 2005, DST awarded him an Emeritus Professorship for his research work on Tetrastichinae, and an USERS grant in 2008 for systematic studies on Eulophidae. In the same year, Harvard University awarded him the Ernst Mayr Grant to continue his work at the Natural History Museum, London.

His hard work and dedication to research in insect systematics brought him many laurels and awards. He was elected a Fellow of the Royal Entomological Society of London (1980), and Fellow of the Indian Academy of Sciences (2000). His commendable achievements in taxonomic studies on parasitic Hymenoptera won him an Appreciation Certificate from USDA, Washington in 1998. He was a founder Fellow of the Indian Academy of Entomology, since 1999. He received the highest honour of the MoEF, New Delhi, the E.K. Janaki Ammal National Award in 2004, in recognition of his outstanding contribution to systematic entomology. In 2008, Kerala Government conferred on him the *Swadeshi Sastra Puraskaram*.

He was a member of many committees and boards like National Biodiversity Authority, Research Monitoring Committee (CES, IISc); National Accreditation Committee (UGC); and Research Co-ordination Committee of the Central Silk Board. He served as the Chairman of Programme

Advisory Committee of the Zoological Survey of India, and Vice President of the Ethological Society of India, Bangalore.

Prof. Narendran published over 394 papers in Indian and international journals and 10 books, including seven monographs on Chalcids of Indo-Malayan and Middle East regions in collaboration with other scientists. Through his revision studies he proposed one new tribe, 1,091 species names, and 55 generic names across many families of hymenopteran wasps. More interestingly, he trained many minds, 26 students in insect systematics, and thereby his legacy will continue for many generations to come. His swiftness in providing identification services to individuals from various institutions in India was remarkable.

The trust which Prof. Narendran founded in 2004 in his name for animal taxonomy, to help small-scale funding for taxonomic research, organizing short-term entomology courses, offers insect identification consultancy services and promotes young taxonomists in India. He was the Chief Editor of the Journal *Biosystematica* and a member of the editorial board of *Journal of the Bombay Natural History Society*, *Entomon*, and *Oriental Insects*.

His service to the scientific field is not fully enumerated here, but only very few are mentioned from among the many. He left behind many incomplete manuscripts and works when he passed away due to a heart attack on December 31, 2013. He is survived by his wife, Mangalabai and two sons, Rajeev Menon and Ranjith Menon. Only by paying more attention to the field of taxonomy can we honour his memory.

■ **Thresiamma Varghese**

REVIEWS

INDIAN MAMMALS – A FIELD GUIDE by Vivek Menon (2014). Published by Hachette India, Gurgaon. Size: 22 cm x 14 cm. 528 pp. Price ₹ 850, $24.99, £20. Paperback.

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This is an enlarged version of Vivek Menon's earlier book with a similar title published in 2003. Like the previous edition, this too is likely to be popular as it is the only field guide on Indian mammals where brief species accounts, particularly the larger and conspicuous species, are accompanied by photographs. The new edition has more photos, some of which are excellent, and larger maps. The species accounts of several species have also been enlarged significantly, providing more data on identification. There are some illustrations of skulls too. Most contributors have been acknowledged and photographers have been duly credited for their photographs, which is a good addition to this revised work. Many species are depicted with photographs from different parts of their range, which helps to understand variations across their range. There are hardly any editorial or grammatical mistakes in this well-designed book.

This said, one cannot ignore the fact that an enlarged edition has its own issues, unless thoroughly cross-checked. In this work, inclusion of subspecies and enlargement of maps has resulted in some mistakes, including disparity between text and maps. In the case of maps, at least for some, revised maps should be pasted upon the existing ones to prevent wrong dissemination of information among the readers, especially as this is a popular field guide. For example, in the case of Capped Langur, the range of the forms *durga* and *pileatus* are separated by elevation (rightly mentioned in the text, p. 90) but the map (p. 91) indicates otherwise. The langurs of the Brahmaputra plains are also *durga*. Almost the entire western Arunachal Pradesh has been excluded as range of the Capped Langur! The photos (p. 91) show both forms – *pileatus* and *durga* – in Kaziranga, which is incorrect. These are photos taken in different seasons when these primates have significant colour variations. The subspecies *assamensis* of Assamese Macaque occurs south of the Brahmaputra river but the map (p. 75) indicates the entire Northeast as its range. The main range of *Macaca munzala* has been mentioned as western Arunachal in the text (p. 76) but the map (p. 77) indicates eastern Arunachal as its major range. The range of Golden Langur (p. 93) has been doubled towards east across the Manas river. For the Muntjac, the text mentions subspecies *vaginalis* in north-east India (p. 156) with a photograph from Kaziranga, but the map excludes both Kaziranga and the bulk of the Northeast (p. 157). The range map of Sambar excludes entire Mizoram, Manipur, Tripura, and western Meghalaya where it still occurs and is even common at some places (p. 159). The range of Gaur also excludes all the main areas of the Northeast such as the entire Manas belt and Karbi Anglong in Assam, the whole of Meghalaya, south-east Manipur, and Mizoram (p. 169). In Tripura, the only confirmed Gaur population is found in Trishna Sanctuary, which is excluded from the map. Inclusion of large areas of Bengal such as Malda and Dinajpur, where there are no records for the last 150 years, is also confusing. The Takin has a much larger range in Arunachal Pradesh and in Sikkim, occurs only in a small corner of south-east (p. 199). In the case of Red Goral (p. 201), the text mentioned only eastern Arunachal Pradesh but the map not only excludes the actual range but includes virtually the entire Northeast south of the Brahmaputra! Regarding the distribution of Pygmy Hog, the locations in Dinajpur (Bengal) and southern Meghalaya (two spots highlighted with circles) are confusing, as the text does not mention these sites where it actually never occurred (p. 205). The map for Clouded Leopard (p. 245) excludes entire Assam, including Karbi Anglong and North Cachar, where this feline has the largest habitat with many records, entire Meghalaya (it is the State Animal) and the bulk of Mizoram. The map of Golden Cat and Marbled Cat also excludes their main range in Assam and the entire Mizoram and Meghalaya (p. 247). In the case of Fishing Cat too, its main range (Brahmaputra valley) is completely excluded (p. 257). Sikkim is omitted from the range for Wolf (p. 277), while the range map of Dhole includes Brahmaputra valley where it hardly occurs, but excludes its entire range in western Assam (Manas belt: common), Meghalaya, Manipur, and Mizoram (p. 281). *Vulpes ferrilata* occurs in a small area of northern Sikkim, but the map shows the entire state and even north Bengal (p. 283). The Red Panda does not occur in the whole of north Bengal but in two tiny pockets (p. 293). Forrest's Pika does not occur in the plains of Assam as shown (p. 329). The Particoloured Flying Squirrel occurs all over the Northeast (p. 381). The subspecies of *Hystrix brachyura* are separated by the Brahmaputra river but the map is a bit strange with many colour shades confined to the south bank (p. 369). Gangetic Dolphin also occurs in southern Assam and Odisha (p. 465).

Though major mistakes have been made in the maps, the text and photographs are a useful feature of this field guide for the Subcontinent.

■ ANWARUDDIN CHOUDHURY

BIRDS AND PEOPLE by Mark Cocker and David Tipling (2013). Published by Jonathan Cape, London.
Size: 28 x 21.5 cm. 592 pp. Price: ₹ 3,960, £ 40.00. Hardback.

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BIRDS AND PEOPLE is a celebration of our relationship with a group of about 10,500 unique avian species whose flight inspires the human imagination. This vast chronicle, dedicated to its 650 contributors from 81 countries, explores the world of birds in human cultures and civilizations. By the authors' own admission, had they done a "comprehensive" study, the work would run to 20 such volumes. This reviewer comes up against a similar obstacle: what to write about and what to leave out of the review. This review mentions but a fragment of the prodigious amount of information that has been compiled by the authors.

Even a cursory attempt to browse through the book leaves the reader amazed at the vast amount of information gathered worldwide. For the purpose of this review, I touch upon some interesting facts about the birds of the Indian subcontinent.

The Indian Peacock *Pavo cristatus* was a forest dweller, which "has become so entwined with the religion, folk culture and destiny of India's Hindu population that peacocks are now birds of scrub, cultivation and even of the village." I may add that they are now birds of towns and cities as well. "These birds have also acquired a secondary role in shaping an outsider's stereotypic impression of India." This introduction to our national bird is followed up with minute details about the call of the peacock, its blue-green feathers as associated with Krishna, its place in Indian mythology as the mount of Kartikeya, the god of war, and a brief mention of the hazard of pesticide poisoning that has decimated the species. The author goes on to describe, with the help of numerous references, the Indian Peacock in Pakistan and China, and then devotes two more pages to illustrations and text on the species in western art and literature, where the bird is sometimes considered an ill omen. The paintings of J.M. Whistler, including the story of his *piece de resistance*, the painting titled *Harmony in Blue and Gold*, are described.

Similar treatment is given to the Common Pigeon *Columba livia*, with lively images of these birds being fed on a Jodhpur street. The Asian Koel *Eudynamys scolopacea*, according to a contributor, is to us Indians what the Common Nightingale is to the British. This bird and many other cuckoos with onomatopoeic names linked to their melodious calls find mention in the book. The same holds good for the Hoopoe *Upupa epops*, commonly called *hudhud*. The importance of this bird in Muslim art and its dark associations with Greek legend are fascinating. Four pages describe the House Sparrow *Passer domesticus*, which shot into prominence following reports of its decline in urban India. As for Family Bucerotidae and its numerous species of hornbills, a photograph of the Great Hornbill *Buceros bicornis* on page 327 and the caption say it all: "It is not difficult to see why the Great Hornbill has been held in such esteem by many of its human neighbours." No wonder it also inspired the BNHS to incorporate this forest flagship species in its logo, the name of its popular magazine *Hornbill*, and of the ENVIS newsletter *Buceros*.

Not a page is wasted in this volume which is enhanced by a brief glossary, followed by two pages devoted to biographical details of the greatest names in ornithology, including Sálim Ali and Allan Octavian Hume.

A final word of appreciation for the second author: David Tipling is one of the foremost wildlife photographers of Europe, and each of his pictures, as they say, is worth a thousand words. He has travelled in 39 countries across seven continents to photograph birds for this volume.

■ GAYATRI W. UGRA

■ ■ ■

MISCELLANEOUS NOTES

1. DIETARY OPPORTUNISM IN DESERT FOX OR WHITE-FOOTED FOX *VULPES VULPES PUSILLA*

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The Desert or White-footed Fox *Vulpes vulpes pusilla*, due to its pelage colour, is treated as a subspecies of the Red Fox *Vulpes vulpes*. It is characterized by its smaller size, lighter build, shorter body fur, less bushy tail, and extensive white areas on outer limbs and paws (Roberts 1997). In western Rajasthan, it is still fairly common and locally known as *Lonki*. Prater (1971) gives its range as from "Rajputana [Rajasthan], Cutch [Kachchh], and Sind westwards into Baluchistan, Persia, and Mesopotamia".

Like other canids, the Desert Fox is the most versatile among carnivores in respect of diet. It is opportunistic and omnivorous, eating several food items ranging from mammals to birds, reptiles, insects, fruits, and carrion. The few fox species that have been studied were found to be opportunistic, eating whatever food is available locally (Johnsingh and Manjrekar 2013; Wilson and Mittermeier 2009). The fox will turn to anything for its diet, and some of the ways it secures its food are amazing (Hemmington 2001). A study by Home and Jhala (2009) on scat analysis suggests that it primarily subsists on arthropods and fruits. According to them, the Spiny-tailed Lizard *Uromastyx hardwickii* is a major component of the fox's diet in Kachchh, Gujarat. In this note, I report a case of unusual feeding opportunism by the Desert Fox.

While birding at Tal Chhapar Wildlife Sanctuary, Churu district, Rajasthan, I observed a Desert Fox preying largely on Spiny-tailed Lizard during the post monsoon period. This lizard is common in the Thar Desert and it is a significant source of food for raptors (Baindur 2009). On October 20, 2010, I noticed a tail-less and blood-splattered lizard sunning itself above its burrow. Obviously, it had got injured while escaping from the clutches of the fox, as I found enough tell-tale signs of the mammal around the burrow. Later, during a brief stay at Tal Chhapar, a fox was observed several times digging up the burrows of the lizard. While no special effort was made to look for burrows, ten damaged burrows were found while walking in the Sanctuary, and these were usually 10 to 22 cm wide at the mouth. The fox's effort varied from a few scratches at a burrow to its total destruction, leaving mounds of earth around it. I assume that after the monsoon the soft ground facilitates digging by foxes. Evaporation is fast in the open grassland and the earth soon hardens around early November. Foxes do not waste energy in digging the hard ground after that. This behaviour was observed again after the monsoon in October 2012, when the ground was soft after rains. Usually, foxes are successful in digging out the reptiles at Tal Chhapar, but are unable to enjoy the hard earned prey. Many-a-times they are deprived of the prey by Imperial Eagle *Aquila heliaca* and Tawny Eagle *Aquila rapax*, which patiently wait for the fox to catch the reptile and then forcibly snatch it away.

One night in August 2013, I saw a Desert Fox following a tractor ploughing the field in my agricultural farm in Chhayan village, *c.* 20 km north of Ramdeora, Jaisalmer district, Rajasthan. There was no light that night for miles around, except for the headlamps of the tractor. A large number of dung beetles (Scarabaeidae) were attracted by the bright light of the headlamps and were flying into them. Those falling on the ground were quickly eaten by the fox. It appeared to be not too perturbed by the farmer broadcasting seeds while walking behind the moving tractor, and just maintained a safe distance from the man. The fox did not leave even when the man shooed it away two or three times. The fox continued to feed for more than half an hour.

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2. FERRET-BADGER RECORDS FROM MIZORAM, MEGHALAYA, AND NAGALAND, INDIA

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Introduction

In India ferret-badgers are restricted to the tropical and subtropical forests and grasslands of northeast India (Datta 2008). This region, comprising the states of Assam, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Meghalaya, and Tripura, forms a part of the biodiversity "hotspots" of the world (Myers *et al.* 2000; Ved and Lalramnuna 2008).

Ferret-badgers are nocturnal, usually active at dusk. Like most badgers they live in holes dug by themselves or in burrows of other animals, and in rock crevices. They are good climbers and often sleep on the branches of trees. They are omnivorous and known to feed on small animals, insects, earthworms, and fruits. They prey upon insect pests such as cockroaches, and therefore, the locals like Lepchas and Bhotias encourage them to enter into their huts (Prater 1980).Their young are born during May and June. Their litter size ranges from 1 to 3, the usual number of individuals in a litter being three. They are born blind, and show the same pattern of coloration as of adults (O' Donel 1916).

In the paper, we give an account of the morphology and distribution of the Burmese and Chinese ferret-badgers that occur in northeast India, and discuss the records of their occurrences based on specimens in museums, our records, and records by other workers.

Morphology and Distribution Range

The Burmese and Chinese ferret-badgers look extremely similar. The main identification character is the size of molar teeth, which is difficult to observe unless caught or examined in a dead animal (Choudhury 1999). The Burmese Ferret-badger is also known as Large-toothed Ferret-badger due to its massive and wide-crowned molars. The Chinese Ferret-badger, because of its small and narrow-crowned molars, is also known as Small-toothed Ferret-badger (Datta 1999; Prater 1980). Due to the difficulties in differentiating between the two species based on external characters, there remains confusion over the range boundaries of both these species in mainland Asia (Schank *et al.* 2009).

Burmese Ferret-badger *Melogale personata* I. Geoffroy Saint-Hilaire, 1831

In India, the Burmese Ferret-badger is distributed from Nepal eastwards to West Bengal, Assam, Meghalaya, Manipur, and Arunachal Pradesh (Chakraborty and Bhattacharya 1999; Datta 1999; Hussain 1999; Pocock 1941; Ramakantha 1992). It weighs around 1–3 kg, has a head–body length of 33–45 cm while the tail length is 12–23 cm (Mudappa 2013). It is listed as Data Deficient on the IUCN Red List of Threatened Species (Duckworth *et al.* 2008a).

Chinese Ferret-badger *Melogale moschata* (Gray, 1831)

In India, the Chinese Ferret-badger is distributed throughout northeast India from West Bengal eastwards to Assam, Manipur, Nagaland, and Arunachal Pradesh (Choudhury 1997; Datta 1999; Hussain 1999; Pocock 1941; Ramakantha 1992). It weighs around 1–3 kg, has a head–body length of 33–43 cm while the tail length is 14–23 cm (Mudappa 2013). It is listed as Least Concern on the IUCN Red List of Threatened Species (Duckworth *et al.* 2008b). It is reported to feed on earthworm, insects, and amphibians (Chuang and Lee 1997).

Museum Records

Burmese Ferret-badger: The Field Museum of Natural History (FMNH) has a specimen (FMNH Mammals 75851) from Mawphlang in Khasi Hills, Meghalaya collected by W.N. Koelz on December 31, 1952 [Anon. (a) n.d.]. There is a specimen from Shillong, East Khasi Hills district (Meghalaya) in ZSI (Choudhury 2013), a specimen from Laitkynsao, Meghalaya (Choudhury 2013; Hinton and Lindsday 1926), a specimen from 'Tipperah Hills' in the Indian Museum, Kolkata (Sclater 1891), and one in ZSI from Tripura district of Bengal (probably Comilla district of Bangladesh) collected by F. Skipuith in 1845 (Choudhury 2013).

Chinese Ferret-badger: The FMNH, Chicago, USA, has a specimen (FMNH Mammals 75850) from Cherrapunji in

Khasi Hills, Meghalaya collected by W.N. Koelz on June 05, 1952. [Anon. (b) (n.d.)]. During the mammal survey of BNHS (see Mills 1923), specimens were obtained from Mokokchung (Nagaland), 1,500 m (5,000 ft) (Choudhury 2013).

Our Records

Mizoram

1. NV and LZ came across a specimen of a ferret-badger at the Mizoram State Museum at Aizawl, referred to as "Mizoram Ferret-badger" (specimen number 2008/7). It was procured from Mr. Lalrinawma of Aizawl on April 24, 2008, but the exact site from where it was obtained is unclear. A Forest Department publication (Anon. 2006) gives the Mizo name of the species as *Sahmaitha*.
2. In the late evening on August 19, 2006, two ferret-badgers were sighted among squash vines *Cucurbita maxima* by locals of Tuikual South locality of Aizawl (23° 43' N; 92° 44' E). One was killed, and the other caught. On August 20, 2006, LZ was called for help in identification of the captured individual, and the animal was released in the nearby forest after photographing it.
3. LZ, during his tenure as the Field Director of the Dampa Tiger Reserve was able to obtain an image of ferret-badger through camera traps in September 2011, in Dampa Tiger Reserve.

Nagaland

On October 18, 2011, at around 10:30 hrs, NV saw a ferret-badger being sold at Benbenzhu (25° 52' N; 94° 10' E; 1,360 m), Kohima district, while driving from Kohima to Mokokchung. It is known there as *Nkie* (Ringma dialect), and the locals said that it is nocturnal, feeds on earthworms, occurs in rocky areas, and was a rare species. NV noticed that the tail tip of the individual was white. The face was darker than the ears with long whiskers almost reaching to the ears. The dorsal side was darker than the belly. Nails were present on all the toes. Despite these details, he was unable to identify the species.

Meghalaya

Samrakshan Trust's Wildlife Distribution Survey taken up in the South Garo Hills showed that 3 and 34 (i.e. 1% and 10% respectively) of the 334 respondents said that they had seen the Burmese Ferret-badger and Chinese Ferret-badger in their areas during the last five years (Ved and Sangma 2007). However, it is most likely that the respondents may not have been able to distinguish between the two Ferret-badger species.

Recent records by other workers

Ferret-badgers have been frequently recorded in various localities of Assam, Arunachal Pradesh, and Meghalaya (Choudhury 2003), but no further information is provided on these reports (Datta 2008). A stuffed specimen of the Burmese Ferret-badger was recovered from a local tribal in Seijusa, Pakhui WLS (Datta 1999). Two specimens of the Chinese Ferret-badger were examined in Namdapha NP and one specimen of Burmese Ferret-badger was recorded near Roing, Dibang Valley district (Chakraborty and Sen 1991; Choudhury 2003). Choudhury (2009) reported ferret-badgers on a number of occasions at Karbi Anglong, Assam, during 1991–92, but did not identify the species. A killed specimen that seemed to be the Burmese Ferret-badger was on sale at Kohima in 1997 (Choudhury 2000). Besides this, two shot animals that appeared to be Chinese Ferret-badger were recorded for sale at the Kohima market in 1997 (Choudhury 2000). A ferret-badger pair was captured from sub-tropical pine forests (1,200–1,500 m above msl) of Chandel district, Manipur (Ramakantha 1992). Several live animals were observed in the wild in Barak valley districts (mainly in Inner Line RF) and Karbi Anglong (mainly in Dhansiri RF) district, which could be either of the two species (Choudhury 2013). Dutta (2008) obtained camera-trap records for the ferret-badgers (species unknown) from Namdapha NP (Arunachal Pradesh), which are the first photographic evidence of ferret-badgers in the wild from India. They were taken during October 2006 – January 2007, and it took on an average 384 camera-trap nights to get each of these images (total effort of 1,537 camera trap-nights).

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3. ON THE OCCURRENCE OF DARK-COLOURED INDIAN OR RED MUNTJAC *MUNTIACUS MUNTJAK* ZIMMERMANN IN SIKKIM-DARJEELING AREAS WITH A RECENT SIGHTING FROM WEST SIKKIM, INDIA

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The muntjacs (Family Cervidae) are a complex group of deer where new variants are still being discovered. The only muntjac known from the Indian Subcontinent was the Indian or Red Muntjac *Muntiacus muntjak* Zimmermann, till the Leaf Muntjac *M. putaoensis* and Gongshan Muntjac *M. gongshanensis* were recorded from Arunachal Pradesh. The Leaf Muntjac has also been recorded in Nagaland (Choudhury 2003, 2013). *M. gongshanensis* is a darker animal. The extralimital Fea's Muntjac *M. feae*, found in Southeast Asia, is also a dark animal. Recently, a dark-coloured muntjac was camera trapped in Senchal Wildlife Sanctuary in Darjeeling district of northern West Bengal (Sunar *et al.* 2012).

I report here an observation made while on a visit to Sikkim. We left Pemayangtse near Pelling, West Sikkim district, in the morning hours, crossed Geyzing (Gyalshing) and proceeded towards Legship enroute to Bagdogra on June 15, 2014. At about 08:00 hrs before reaching Legship (27° 16′ N; 88° 16′ E), we came across two adult muntjacs – one in the middle of the road and the other along it. The first animal was a typical *M. muntjak* with a reddish coat. The other was a dark animal, rather brownish-grey overall (Fig. 1).

I had crossed this stretch on several occasions from March to May 2014 while posted as Election Observer, but except for a few Assamese Macaque *Macaca assamensis*, on only one occasion, no other mammals were seen, and for this reason did not have my camera ready to photograph it.

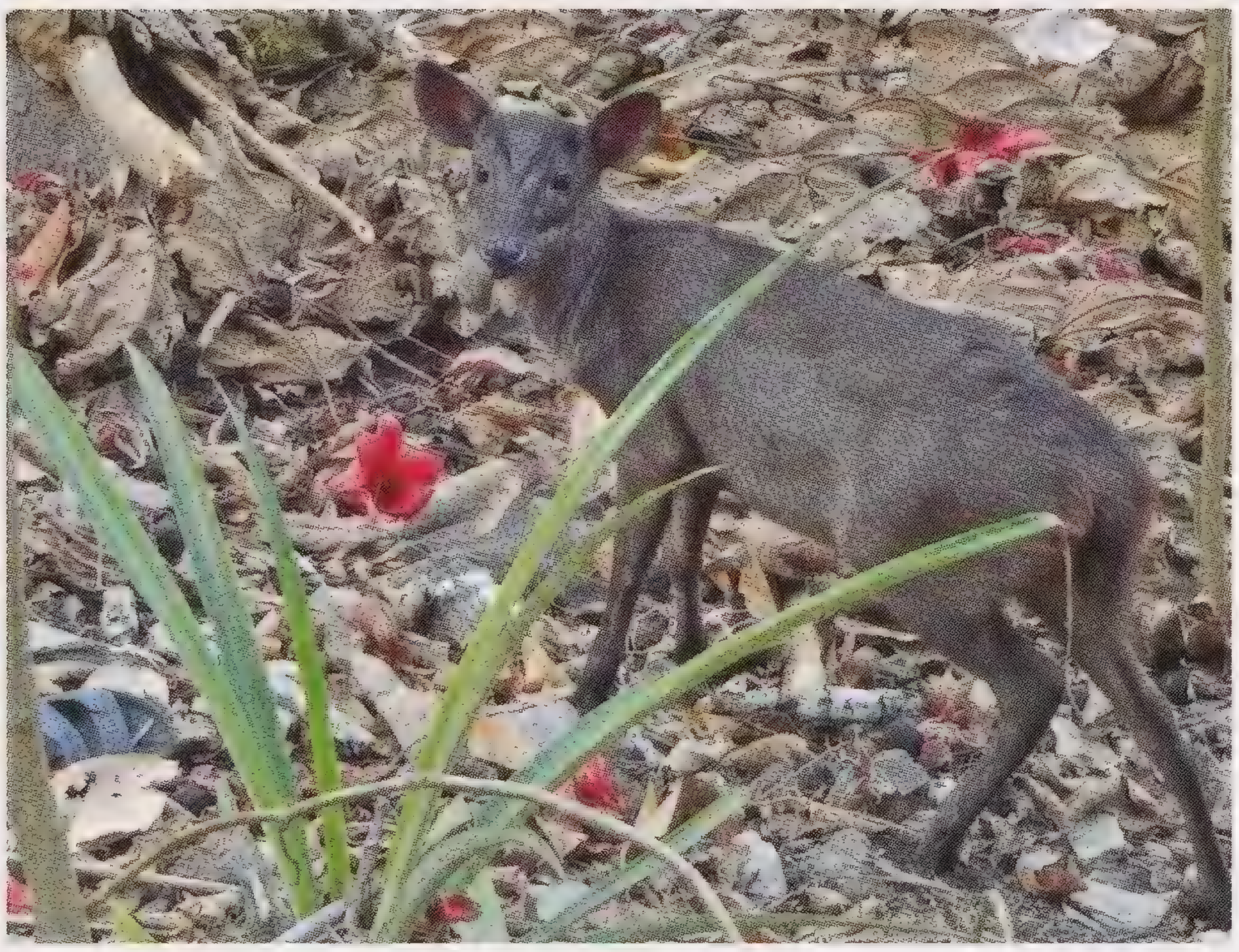
CHANGA LACHUNGPA

Fig. 1: The dark coloured muntjac *Muntiacus muntjak* in South Sikkim district

Hence, I used my mobile phone to take a photo of the darker animal – the animals did not panic but tried to move away. A car from the opposite direction disturbed the deer, one crossed the road and vanished into the wooded slope while the dark animal turned back and climbed up the old road side-cutting, where I could notice a young with it. The fawn was dull reddish-brown. The habitat was light forest with young sal trees *Shorea robusta* and other shrubs with some grass including *Thysanolaena maxima*. The elevation was around 700 m above msl.

Had the dark animal been alone, its sighting could have lead to the assumption that it was an undescribed form of muntjac or the Gongshan Muntjac, but the presence of a normal coloured muntjac along with it indicated that it was a dark morph of *M. muntjak* During subsequent visits to Sikkim in September 2014, again as Election Observer, I got reports of muntjacs with dark coats from the South District. The local Forest Department officials reported a sighting in Kitam Bird Sanctuary, and once an injured juvenile (attacked by a Yellow-throated Marten *Martes flavigula*) was rescued from near Phungla in October 2013. It was rescued, treated, and released back into the wild (Nischal Gautam, Divisional Forest Officer; Hari Maya Thapa, Range Officer and Changa Lachungpa, Beat Officer, all of wildlife wing, Namchi, pers. comm.) – (Fig. 1). They also informed of the rescue of a few more such animals from Soreng area of West District in the past, although the exact dates are not known. The districts of South and West Sikkim are adjacent and contiguous with the Darjeeling district of West Bengal, and all the recent records of dark coloured muntjacs are from this belt. So far, there has been no record of the Gongshan Muntjac, also a dark-coloured animal from the west of the Brahmaputra–Siang divide in China.

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4. SIGHTING OF THE RED-BILLED TROPICBIRD *PHAETHON AETHEREUS* FROM GOPALPUR-ON-SEA, ODISHA, INDIA

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The Red-billed (or Grey-Backed) Tropicbird *Phaethon aethereus* is a pelagic species occurring in the northern part of the Indian Ocean. It has also been recorded off Pakistan coast, west coast (Mumbai, Kerala), Lakshadweep, Andamans, and Sri Lanka (Ali and Ripley 1987; Manakadan *et al*. 2011).

During a trip to Gopalpur-on-Sea on June 27, 2013, we were photographing Brahminy Kites *Haliastur indus* that were flying in good numbers overhead while sitting on the balcony of Hotel Kalinga. It was around two in the afternoon, and suddenly, we saw a white bird with long white tail-steamers and red bill, flying from the beach. It was flying at a height of 8 m, and we were able to see the bird at eye level from the balcony. It was a fast flier. The bird crossed us and after a short while, came back and disappeared in the direction from where it came from. We managed to click a few photographs of the bird, and identified it as an adult Red-billed Tropicbird *Phaethon aethereus* after referring to field guides. Our sighting makes this the first record of the species from the Odisha coast.

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5. GREY-FACED BUZZARD *BUTASTUR INDICUS*: FIRST RECORD FROM INDIA

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The Grey-faced Buzzard *Butastur indicus* breeds in Eastern Palearctic and winters in Myanmar, Thailand, Malaysia, Indochina, Indonesia, and Hong Kong (Ferguson-Lees and Christie 2001; King *et al*. 1983). There is no record of the species from mainland India and the islands (particularly from Andaman and Nicobar). On March 25, 2013, during a field trip in Narcondam Island, we sighted around 12 raptors soaring, mostly Crested Serpent Eagle *Spilornis cheela*, and probably a few Andaman Serpent Eagle *S. elgini*. One among them was very different and appeared to be a buzzard. We sent the photographs to Dr. Vibhu Prakash and William Clarke who independently identified it as Grey-faced Buzzard *Butastur indicus*. The species is new addition to the birds of India (and the Indian subcontinent), as none of the books (Ali and Ripley 1987; Grimmett *et al*. 2011; Manakadan *et al*. 2011; Rasmussen and Anderton 2012) have listed this species from India. It should be mentioned here that although Narcondam Island is politically in India, geographically it is closer to South-east Asia than mainland India. It is around 80 miles from Myanmar and around 252 miles from Thailand where this species is regularly seen. Therefore, it is likely that the Grey-faced Buzzard is regularly found during migration in Narcondam Island.

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6. FIRST RECORD OF PECTORAL SANDPIPER *CALIDRIS MELANOTOS* AND CASPIAN PLOVER *CHARADRIUS ASIATICUS* FROM KERALA, INDIA

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Madayipara (12° 02′ N; 75° 16′ E; 40–47 m above msl), *c*. 22 km north of Kannur in Kerala, is a large laterite hillock with sparse grass and open rocky areas, wedged between the Western Ghats and the Arabian Sea. It is a hotspot for migratory passerines, and the site where the Buff-breasted Sandpiper *Tryngitis subruficollis* was first photographed from South Asia (Rajeevan and Thomas 2013). The first sightings of the Isabelline Wheatear *Oenanthe isabellina* and Tawny Pipit *Anthus campestris* in Kerala were also from Madayipara (Rajeevan *et al*. 2012).

On a routine birding trip to Madayipara on September 19, 2013, PCR spotted a brownish bird among a flock consisting of Lesser Sand Plover *Charadrius mongolus*, Curlew Sandpiper *Calidris ferruginea*, Little Stint *Calidris minuta*, and Broad-billed Sandpiper *Limicola falcinellus*. This bird was about the size of a Curlew Sandpiper. The bill was narrow and long with a reddish-brown base and black tip. The breast was well-streaked. As it flew away, PCR saw that there was white on both sides of the rump and black at the centre of the tail. On the basis of these, he identified the bird as the Pectoral Sandpiper. Later KMK and JT joined him and took photographs, and the identification was confirmed by experts. The bird was seen till September 22.

Birding further along on the same day, PCR noticed another bird. This bird was of the size of a Greater Sand Plover *Charadrius leschenaultii* with pale yellowish-brown plumage and broad white supercilium. The legs were long and greenish-yellow. The bill was black and somewhat similar to the Greater Sand Plover, but finer and pointed. The breast band was slightly visible and a white wing-bar was clearly seen in flight. The photographs of the bird taken by JT were sent to experts, who identified it as Caspian Plover. The bird was recorded in the area till September 30.

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The authors are thankful to C. Sashikumar, Praveen J., Dipu K., and Muhamed Jafer Palot for help in identifying the Pectoral Sandpiper, and Harkirat Singh Sangha for confirming the identify of the Caspian Plover, besides other birders. We extend our sincere thanks to Mr. K.P. Chandragadhan, Secretary of Madayipara Protection Council, and A. Mohan Kumar for their wholehearted support and encouragement.

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7. FIRST RECORD OF RED-NECKED PHALAROPE *PHALAROPUS LOBATUS* FROM KERALA, INDIA

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The Red-necked Phalarope *Phalaropus lobatus* (Linnaeus) is considered a winter visitor to seas (usually 10–50 km offshore) from South Pakistan till Gujarat and also wintering in SE India and Sri Lanka (Grimmett *et al.* 2011; Rasmussen and Anderton 2012). It is also a widespread passage migrant throughout India with several inland records (Ali and Ripley 1987), including recent photographic records from Mysore (2009) and Coimbatore (2012). However, this bird has never been recorded from the SW coastal waters south of Goa.

During a pelagic expedition in South Kerala, a Red-necked Phalarope *Phalaropus lobatus* was observed in the Arabian Sea (8° 54′ 58″ N; 76° 29′ 15″ E; depth: 18.39 m), about 9 km offshore from Neendakara estuary, Kollam district on October 30, 2012, at 16:30 hrs. The sea was a bit turbulent and a strong wind was blowing in a southwest to northeast direction. The bird was first spotted flying over the water, and it settled quickly, floating on the waves very close to the boat, enabling several photographers in the boat to photograph it. It kept around the boat for about 10 minutes before flying away.

The bird was moulting to first-winter plumage: it had a brownish crown and hind-neck, and showed several freshly-grown adult scapulars. It had a clear white circular spot on the breast-sides, level with and just in front of the first upper scapular. The normally distinctive white “V” on the mantle was not very obvious, presumably because of the onset of moult into winter plumage. In flight, the bird was dark above and pale below with a well-defined, relatively narrow, white wingbar on the upperwing. The long, thin, black bill (contra shorter, pale-based bill) was the key feature to distinguish it from the Red Phalarope *P. fulicarius* which is a vagrant to the Indian subcontinent. The presence of a clear white wingbar and its structure eliminated the unlikely possibility that it was the extralimital Wilson’s Phalarope *P. tricolor*.

This constitutes the first record of Red-necked Phalarope in Kerala. However, this observation is not surprising, as the species is predominantly pelagic in winter and it is only in the last two years that much birding has been done at sea. The species breeds in low-Arctic region in May to August and is a winter visitor to the coasts of Peru, equatorial West Africa and the Arabian and South China Sea (Harrison 1995).

Since our submission, there has been a more recent photographic record of this species from the Arabian sea off Kerala coast on September 28, 2014, by several birdwatchers on a similar pelagic survey (Jinesh 2014).

ACKNOWLEDGEMENTS

The authors are grateful to the authorities of Kerala State Fisheries Department for permission to undertake the survey in Kollam and Thiruvananthapuram districts. We would like to acknowledge our fellow birdwatchers who accompanied us during the pelagic survey. The first author is grateful to the Director, Zoological Survey of India, Kolkata, and the Officer-in-Charge, ZSI, Calicut, for facilities and encouragements.

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8. ORIENTAL SKYLARK *ALAUDA GULGULA* NESTING IN ELEPHANT DUNG IN CORBETT TIGER RESERVE, INDIA

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The Oriental Skylark *Alauda gulgula* is resident in India (Rasmussen and Anderton 2012), and found throughout much of the subcontinent, except for parts of the northwest and northeast (Grimmett *et al.* 1998). The species is known to occur in open grasslands (Kazmierczak 2000) on the edge of jheels (Ali and Ripley 1987). It breeds in the western Himalaya from May to July (Ali and Ripley 1987) and builds a cup-shaped nest of grass, usually under an earth clod or grass tuft (Grimmett *et al.* 1998). "The nest is made in a natural depression in the ground, such as cattle hoof-print or maybe partly scraped out by the bird itself and comprises a hollow cup woven of grasses and lined with animal hair or finer roots" (Roberts 1992).

The Dhikala grassland is an area of roughly 10 sq. km in the Patli Dun valley of Ramganga river, located in the heart of Corbett Tiger Reserve. It is an undulating, riverine grassland, located on the upper end of Ramganga reservoir. The Oriental Skylark is a common resident bird, found throughout the year in the grassland. The species has been observed to breed in this area during the months of May and June (*pers. obs.*). On June 15, 2008, J.P. Khulbe brought to my attention an interesting nest site of the species at Leed Khalia area (29° 35′ N; 78° 49′ E; *c.* 347 m) in Dhikala grassland. The nest was placed in a hollow, excavated in a dry elephant-dung ball. It was made of dry grass vegetation lined with soft thin grass strands. The nest, located on high ground and at a distance of 20–25 m from the edge of the reservoir, was facing south-west. It is presumed that the orientation of the nest provided safety from the heat of the sun during the hot season. There were three chicks in the nest. The chicks were young and had dirty white, downy feathers over some parts of their body, with the rest of the body still unfeathered. The nest was videographed, and the chicks responded by opening their gapes, apparently seeking food, mistaking the clicking sound of the video camera whenever it was switched on or off for the calls of the parents. Two chicks, apparently a little older than the third, were more aggressive in demanding food. Later, the nest was observed for over ten minutes from a distance and the parents brought feed twice during this period. The adult was a medium-sized lark, with pale coloration, streaked above, streaked on the breast, and with a white unmarked belly and vent. It had a short streaked crest, a fine bill, buffy white outer-tail feathers, and rufous tinge to the flight feathers.

Some lark species are known to use animal dung for nesting materials: Beesley's Lark *Chersomanes beesleyi* uses dung to line the nest; Black Lark *Melanocorypha yeltoniensis* has its nest site often surrounded by animal dung; Bimaculated Lark *Melanocorypha bimaculata* uses dung to construct the outer walls of its nest; and Red-capped Lark *Calandrella cinerea* is known to use dung to make the ramparts of its nest (del Hoyo *et al.* 2004). The rim of the nest of Large Crested Lark *Galerida cristata* has been recorded to be lined with bits of baked cowdung (Ali and Ripley 1987). The only species of lark that has been reported to place its nest in animal dung is Botha's Lark *Spizocorys fringillaris*, with a record of a nest placed in a pile of sheep dung (del Hoyo *et al.* 2004).

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9. CAPTURING PROBLEM SALTWATER CROCODILES *CROCODYLUS POROSUS* SCHNEIDER USING INDIGENOUS TECHNIQUES IN THE ANDAMAN ISLANDS, INDIA

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Introduction

The Andaman & Nicobar Islands are known for their rich biodiversity resources (Mathur and Padalia 2010). The archipelago comprises 572 islands, islets, and rocky outcrops extending over 800 km and located between 6° 45′–13° 30′ N and 90° 20′–93° 56′ E. The topography is hilly and undulating, and Saddle Peak is the highest elevation (732 m) in North Andaman Islands. The Saltwater Crocodile is found in the northeastern coastal region of mainland India and the Andaman & Nicobar Islands (Singh and Kar 2006). In the Andaman Islands, it is widely distributed, but population expansion appears to be constrained by the lack of suitable breeding habitat. Human occupation is displacing crocodiles and recent studies have examined the human-crocodile conflicts in this area (Andrews and Whitaker 1994; Kumar *et al.* 2012; Whitaker 2008).

The human response and management action towards crocodiles that attack and kill livestock or people is complex. As crocodile conservation programmes succeed, and human populations expand, interactions between the two become more frequent and problematic. These problems are especially intense when people (e.g., recent migrants) who are inexperienced in sharing resources with crocodiles are subjected to the conflict.

People's perception of risk from natural events and creatures has been well-studied (Ross 1998) and increases as the consequences become serious (injury or death), and the frequency of events increases but the predictability is low. Most influential is the degree to which people feel they can influence the probability of attack and the outcome. When people feel helpless and powerless, their fear and concern rises. When people feel they have some control, their tolerance and willingness to manage and accept risk rises. Fear, panic, revenge killing, and inappropriate management actions such as crocodile nest destruction compromise conservation and cohabitation of people and crocodiles. Understanding and applying indigenous knowledge and beliefs is one tool to improve effective management of crocodiles, empower local people, and provide a setting where crocodile conservation and people can coexist.

This was the second incident of capture of a problem Saltwater Crocodile in Andaman & Nicobar Islands. The first individual was captured using locally available and indigenous methods on June 6, 2010, when the crocodile killed a 25-year old American tourist off Radha Nagar Beach, Havelock (Kumar *et al.* 2012). In this paper, we describe the capture of another problem saltwater crocodile using indigenous techniques.

Capture and translocation of problem crocodile

A Saltwater Crocodile attacked Ajay Kulla, a 23-year old youth of Bakultala village, Middle Andaman on August 01, 2012, at 09:00 hrs, when he was fishing in a nearby nullah along with his friend. His friend witnessed the incident and alerted the villagers nearby, but when they reached the spot Ajay was missing. Despite their best efforts, officials of the Department of Environment & Forests and Police could not trace the victim's body. This was the fifth fatal attack by a crocodile within a period of 28 months in Andaman & Nicobar Islands.

Immediately, the Department of Environment and Forests advised locals to be vigilant of the presence of crocodiles around Bakultala village, and a warning signboard was placed at a nearby mangrove creek. Consequently, a squad was constituted on August 01, 2012, under the direction of the Principal Chief Conservator of Forests (Wildlife) to capture the problem crocodile in order to mitigate crocodile attacks following the unfortunate event. The squad members included the staff of Department of Environment and Forests, local people, and the Police Department. The animal was monitored by direct and indirect observations (e.g., foot prints, faecal matter) on the shore in shallow water, mudflats, and mangrove creeks. After a month-long operation, the problem crocodile was captured from Shyamkunj mangrove creek by the team of the Department of Environment and Forests and successfully shifted to Mini Zoo, Port Blair.

Capture of the problem crocodile

The captured adult male crocodile was 4.10 m long, and weighed 450 kg (Fig. 1). The team members thoroughly combed the entire area and singled out the problem animal based on various characters and set traps to capture it. Three methods were employed to capture the problem crocodile in Bakultala mangrove creek. At first, a cage constructed of bamboo (*Bambusa bambos* and *B. vulgaris*) was placed in the mangrove creek; this attempt was unsuccessful as the cage was too small (Fig. 2). Secondly, a snare trap – a technique used nationally and internationally to capture crocodiles – was attempted. In this method, a wooden dowel was placed inside a dead chicken, and a rope tied to it extended from the chicken's body to buoys that would help to trail the crocodile. The team waited for the crocodile to swallow the bait. Once the bait was taken, the team followed the crocodile for more than two hours, but could not capture it because of accessibility issues within the mangrove creek area, and also because the crocodile regurgitated the bait.

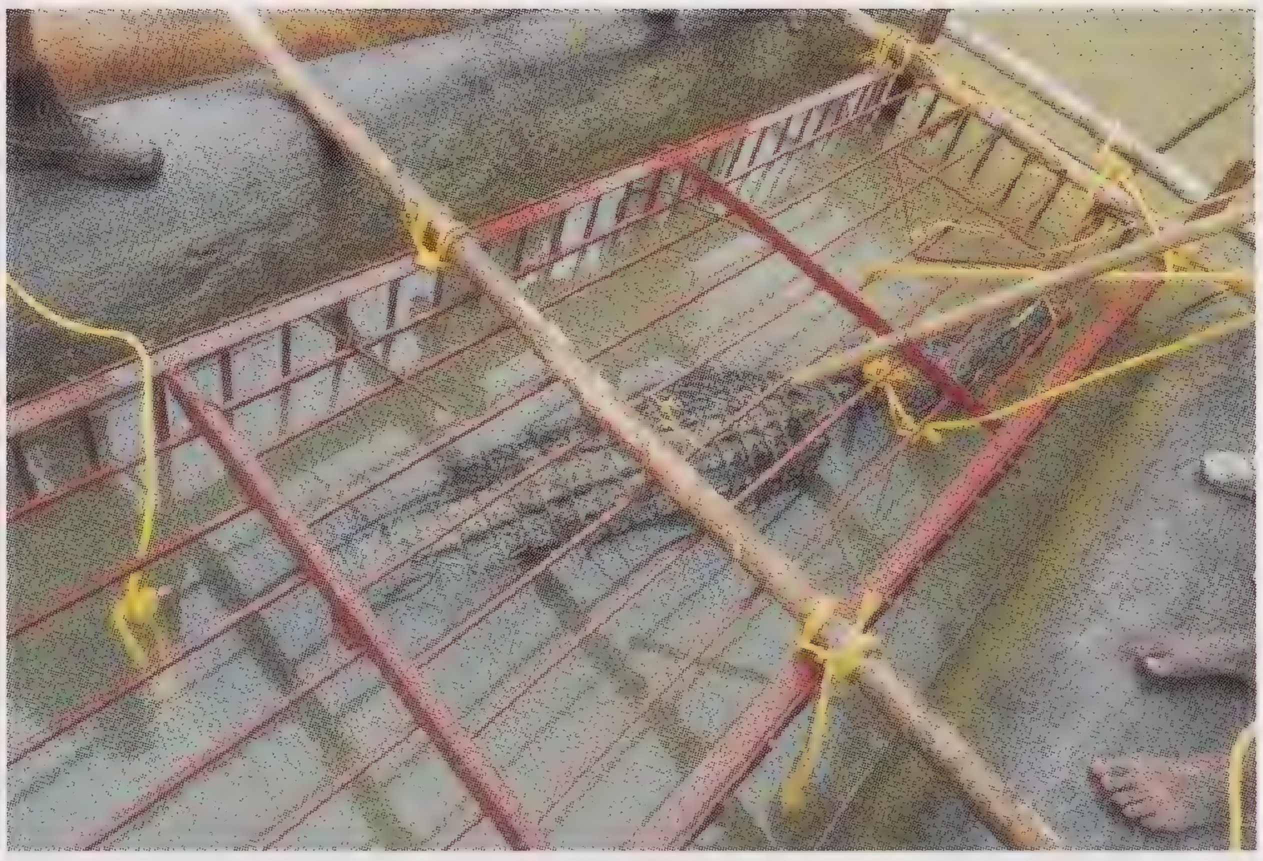

Fig. 1: Captured crocodile

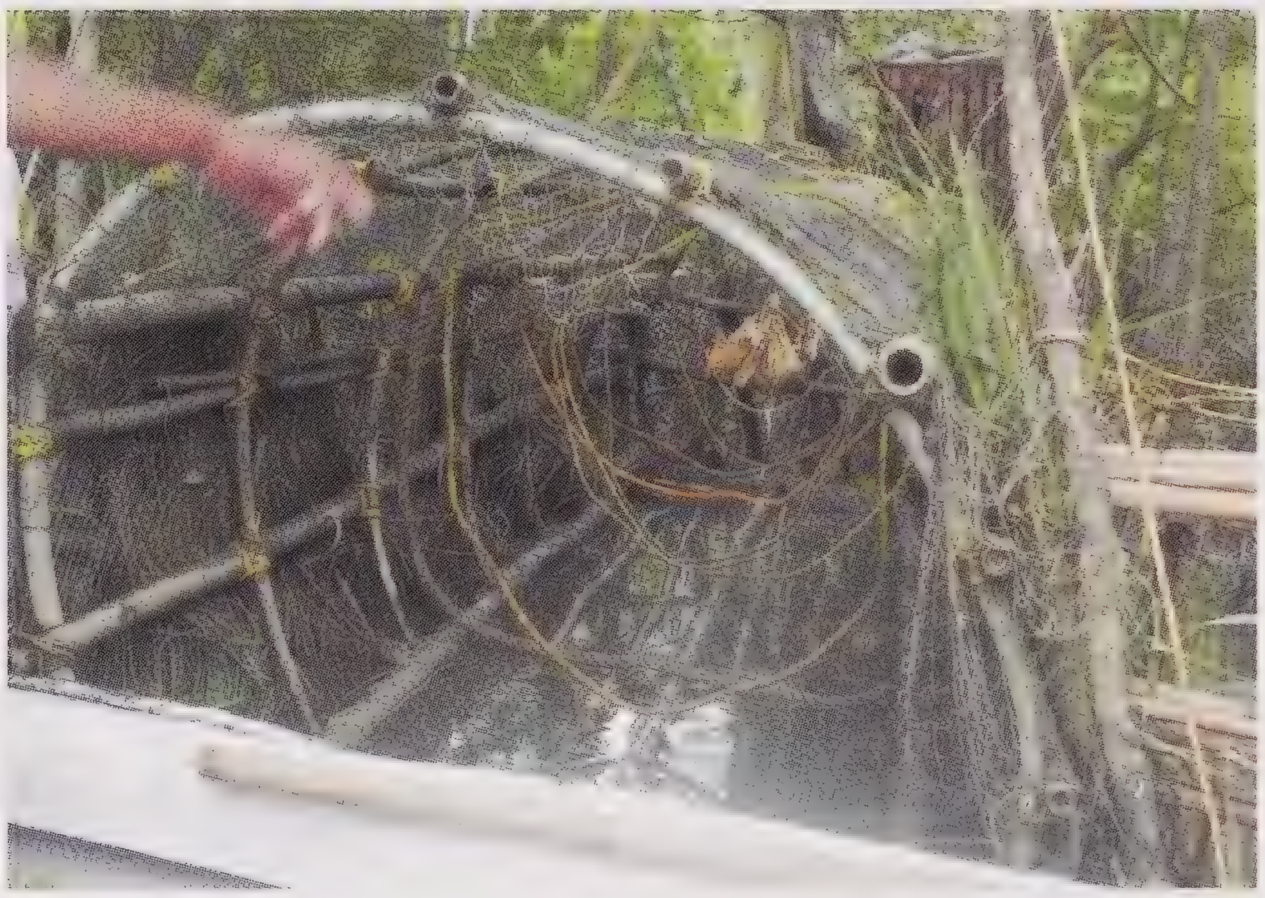

Fig. 2: Cage made with bamboo

Thereafter, a metal cage was devised by the team. The cage was first placed on the shore with chicken as bait, unsuccessfully. Then the cage was placed in the territory of the crocodile in open water using floater logs, and baited with dead chicken (Fig. 3). After 27 days, the target crocodile bit the bait. This was the second largest crocodile captured so far in Andaman & Nicobar Islands and was suspected to be the man-eater. The captured individual was transported to Shyamkunj Jetty on a dinghy. Thereafter, the cage was further improved with planks to avoid any injury to the crocodile during transportation. Finally, the animal was transported to Port Blair by road and relocated to the Mini Zoo at Port Blair.

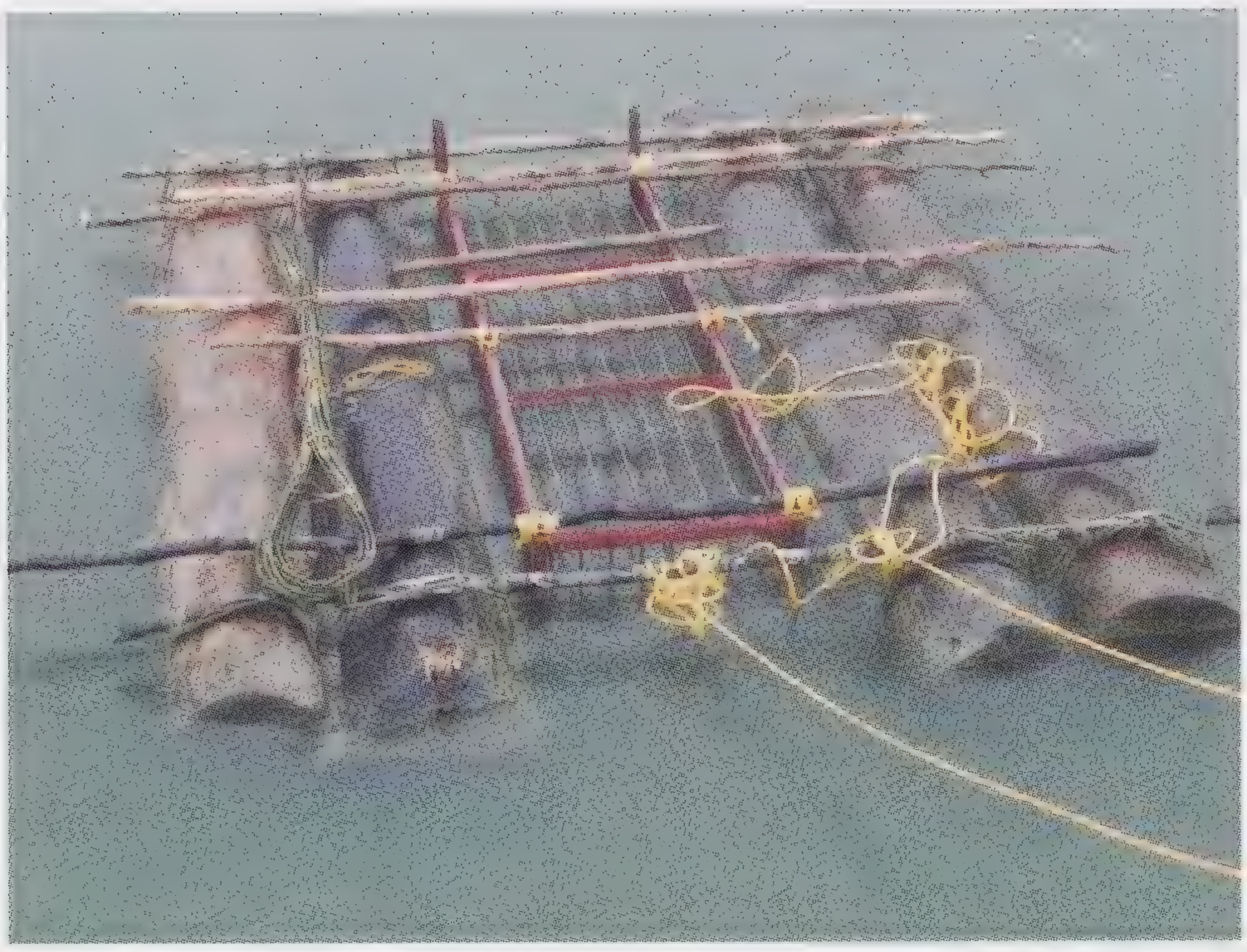

Fig. 3: Metal cage with floater logs

This immediate action by the Department of Environment and Forests temporarily restored the safety and well-being of the local population in Bakultala village. It is very likely that another large male will dominate the area, and again pose a threat to people and their livelihoods.

Possible reasons for attack

Destruction of crocodile habitat, and habitat sharing by humans and crocodiles, are the major reasons for human-crocodile conflict. Increasing human activities, such as fishing in the mangrove areas and crossing the creeks without adequate protection result in crocodile attacks on humans. Another possible reason for attacks on people is nest defence by females. The presence of livestock and other domestic animals on the seashore may also attract crocodiles to inhabited areas. The dumping of waste food materials on the seashore provides an added attraction for crocodiles. It is possible to manipulate the size distribution of the crocodiles by removing some of the larger and more dangerous individuals to other locations in the Islands (Ross 1998). Relocation of problem crocodiles has been suggested as a management strategy in Australia (Walsh and Whitehead 1993). However, experiences in relocating large specimens of *C. porosus* in Darwin, Australia, suggest that some of these animals return to their capture area after relocation up to 100 km away. The best solution is to change people's behaviour so that they are unlikely to encounter crocodiles. In Sri Lanka, communities construct riverside barriers with local materials to provide safe areas for bathing and water collection. Education about the presence and danger of crocodiles, improved (larger) fishing craft, and careful disposal of organic waste such as fish and meat offal can reduce the risk of crocodile attack. Presenting such information in local languages and in forms familiar to local communities (dance, music, theatre, religious discussion, folk belief, and folk tales) and by local communicators, leaders, and opinion makers assists effective transfer of these messages.

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10. RECORD OF THE RARE BIBRON'S CORAL SNAKE *CALLIOPHIS BIBRONI* FROM NELLIYAMPATHY HILLS, KERALA, INDIA

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We encountered Bibron's Coral Snake *Calliophis bibroni* (Beddome 1864; Boulenger 1896; Jan 1858) at Nelliyampathy (10° 25′–10° 30′ N; 76° 35′–76° 45′ E) at an elevation of 1,050 m adjoining the buffer area of Parambikulam Tiger Reserve (PTR) in Kerala (Fig. 1). The snakes were identified by their dark dorsal coloration, orange-red bands, and characteristic head scales, i.e. absence of pre-ocular scales, prefrontal scale in contact with third upper labial, and paired sub-caudals. Scale counting of one of the specimens revealed mid-body scale rows of 13:13:13 and 38 sub-caudal scales, which were consistent with the observations made by Deepak *et al.* (2010), whereas a count of 253 ventral scales differed by 2 scales (251 scales) from Deepak *et al.* (2010). This species was spotted thrice in a period of 15 months during 2012–2013, of which two sightings were made at 19:35 hrs and 20:00 hrs respectively at Pakuthipalam (10° 27′ 39.88″ N; 76° 40′ 50.95″ E), and the third at 18:30 hrs close to Victoria (10° 27′ 57.05″ N; 76° 40′ 40.75″ E). During all these sightings, the snake was always spotted on the forest floor. The relevance of the current records is considerable, since the species is 'rare' (Wall 1919), 'endangered' (Molur and Walker 1998), and information on the natural history, distribution, ecology (Deepak *et al.* 2010), and behaviour of the species is scarce. Moreover, the species has never been reported from Nelliyampathy hills or PTR in Kerala and only a single scientific publication reports its presence south of the Palghat Gap in the Western Ghats (Deepak *et al.* 2010).

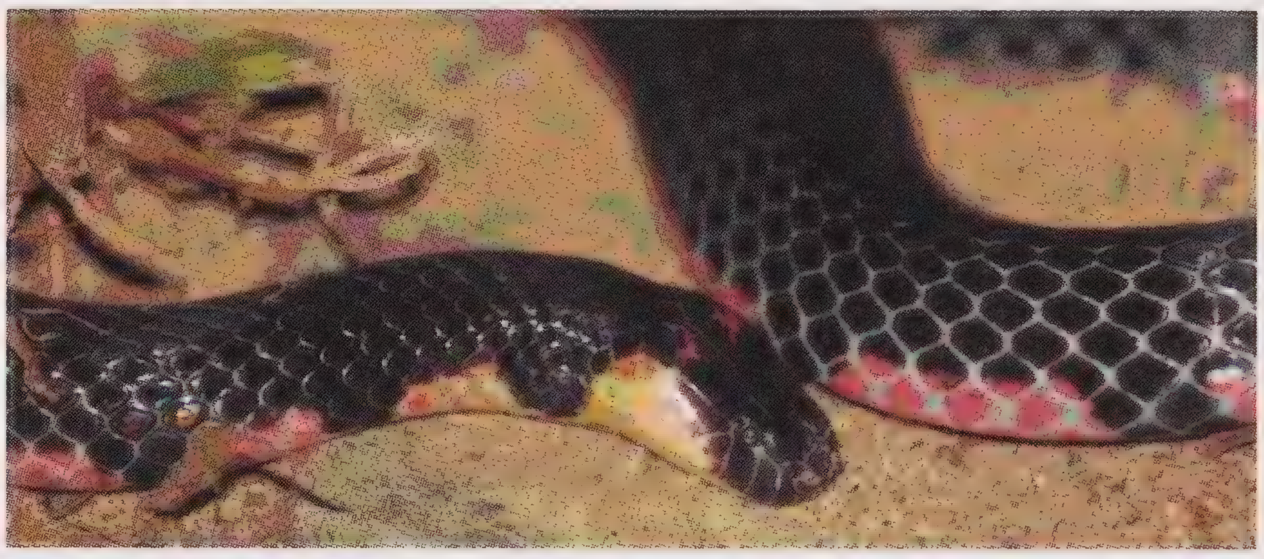

Fig. 1: Bibron's Coral Snake photographed in Victoria, Nelliyampathy, Kerala, illustrating its characteristic head morphology and body coloration

Bibron's Coral Snake is endemic to the Western Ghats and is listed as a species of Least Concern (IUCN 2014) since its distribution is stated to be wide, and population status unlikely to be low or declining. In sharp contrast to the justification given for its current status, IUCN (2014) also states the species to be 'rare' and insufficiently assessed. Earlier records from south of the Palghat Gap exist from specimens collected from Chathankode, Kerala (BNHS 3460, 2002) and Anamalai Tiger Reserve, Tamil Nadu (ZS1, Calicut 2123; ZSI, Kolkata 25638; ZSI, Kolkata 25639) along with an anecdotal newspaper report from Kalamkulam, Kerala (Deepak *et al.* 2010). Therefore, this is only the second publication reporting the occurrence of this species south of the Palghat Gap, broadening the current knowledge of its distribution.

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11. *APOGON HYALOSOMA* BLEEKER (PISCES: PERCOIDEI: APOGONIDAE) – A NEW REPORT TO KERALA, INDIA

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Introduction

Bleeker (1852) described *Apogon hyalosoma* (Family Apogonidae, Suborder Percoidei, Order Perciformes) based on the description of *Apogon thermalis* in 1832 from Singapore, Ambon, Batavia, Sumatra, and Indonesia. Day (1878) reported 14 species of the genus *Apogon*, including *A. hyalosoma* from the Red Sea and east coast of Africa through the seas of India and Malay Archipelago. *A. hyalosoma* is abundant off the Sind and Mumbai coasts, and Andaman Islands (Day 1878). Herre (1925) reported *A. hyalosoma* from Philippines as *Mionorus bombonensis* and as *A. hyalosoma* when collected from the Andamans, in 1939 and 1941 respectively. Munro (1955) also described *A. thermalis* Cuvier as a synonym of *A. hyalosoma*. Thresher (1984) collected *A. hyalosoma* from Philippine Is. and reported it as *M. bombonensis*. Subsequently, *A. hyalosoma* was reported by Letowrneur *et al.* (1988), Blaber *et al.* (1991), Donaldson and Myers (2002), Kottelat (1993), and Thollot (1996). Recently, Palavai and Davidar (2009) recorded the presence of *A. hyalosoma* in the fresh waters of Andamans. *A. hyalosoma* is widely distributed in the coastal waters of most countries in Southeast Asia, except Myanmar, and in the western Pacific Ocean, including the coast of Papua New Guinea (Anon. 2013).

In this paper, we record its occurrence in an estuary in Kerala, the first report of *A. hyalosoma* from the state. The species was collected by cast nets from Vayalkara at Puthenvelikkara, Ernakulam, which is an estuarine area of the River Periyar (10° 7′ 50″ N; 76° 17′ 13″ E), in October 2011. The samples were preserved in 10% formaldehyde and deposited in Maharaja's College Zoology Museum with Accession No. MCZMF-305. Morphometrics, meristic counts, and identification were done following Day (1878) and Munro (1955). Measurements were taken to the nearest 0.1 mm by using dial calipers, and body proportions expressed as percentages of standard length (SL) and head length (HL). Below, we give the biometrics of the specimens examined from the collection at Vayalkara.

Description

Morphometric data based on four specimens collected are given in Table 1 and the general body shape in Fig.1.

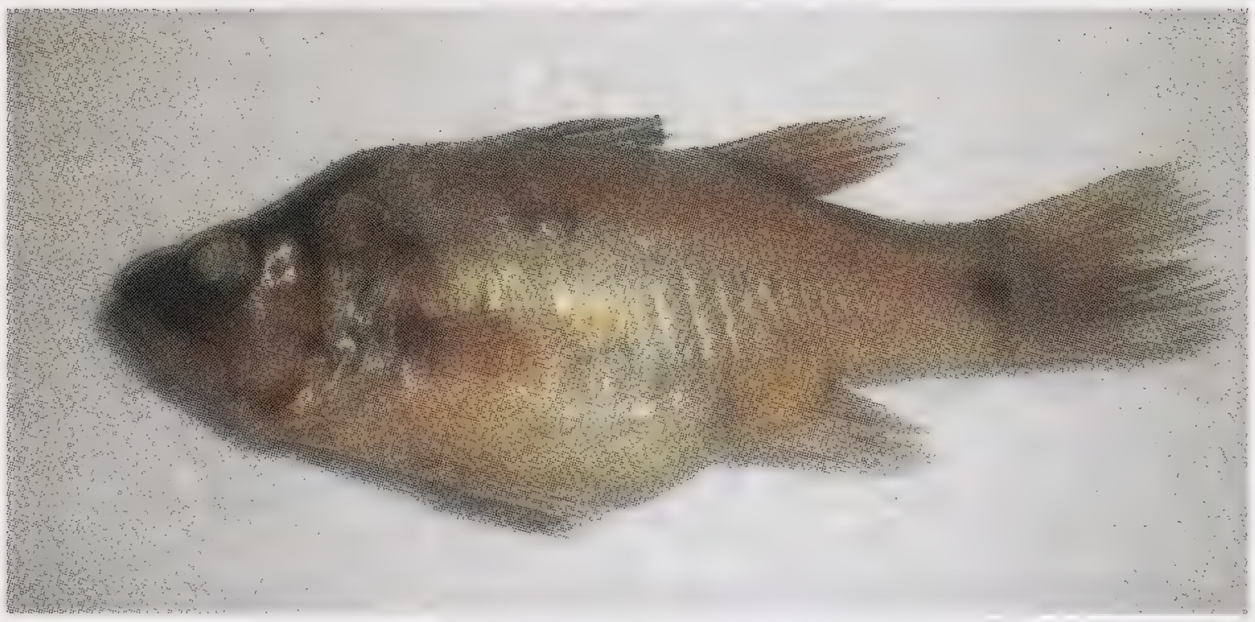

Fig. 1: *Apogon hyalosoma* Bleeker, (MCZMF 305,121.3 mm SL) collected from Periyar at Vayalkara, Ernakulam

D1 VI, D2 I + 9; A II + 8; P 14; V I + 5; C 17; Ll 26; PDS 8; Ltr 2/7.

Body is robust and rhomboid, with standard length (SL) 120.2–122.4 mm, depth 34.4–38.6%, pre dorsal length 44.0–45.8%, post dorsal length 73.3–75.0% and pre pelvic length 41.5–42.3% of SL. Head moderately large, head length 40.7–42.3%, depth 23.5–25.7% and width 15.9–17.9% of SL. Snout short, elevated, snout length 24.1–28.6% of head length (HL). Mouth oblique, lower jaw slightly longer, maxilla reaches below the hind end of orbit. Eyes large, eye diameter 24.2–25.2% of HL. Nape concave, nape width 17.9–19.1% of HL. Both rims of preopercle feebly serrated, other bones of head and shoulders entire. Teeth on jaws, vomers, and palatine. Branchiostegal rays 7. Two dorsal fins, first with 6 strong spines, the membrane between 2nd and 3rd black. Pectoral fins slightly longer than ventrals, pectoral fin length 21.4–24.6% and length of ventral fins 18.3–21.2% of SL. Anal fin with 2 strong spines, anal fin length 15.0–17.1% of SL. Soft dorsal as high as anal. Caudal fin emarginate, a large round black spot at the end of caudal peduncle, similar small spots present at the end of base of soft dorsal and anal fins. Body creamy white with dark pigmentation on dorsal side in some specimens. Lateral line complete, with 26 scales.

Discussion

The specimens of *Apogon hyalosoma* collected by us match the description of the species by Day (1878) in many biometric characters, such as rhomboid body, large eyes,

Table 1: Morphometric data of four specimens of *Apogon hyalosoma* collected from Periyar at Vayalkara, Ernakulam

Characters	Length (in mm) of fishes				range	mean	+/- Std dev
	I	II	III	IV			
Total length	145.3	145.1	145.7	144.1	144.1–145.7	145.0	0.8
Standard length	120.2	121.3	122.4	121.3	120.2–122.4	121.3	0.9
Body depth	41.2	46.1	45.0	46.9	41.2–46.9	44.8	2.4
Head length	48.9	50.7	51.8	50.9	48.9–51.8	50.5	1.2
Head depth	28.3	31.2	31.4	30.3	28.3–31.4	30.3	1.4
Head width	21.2	19.3	22.0	19.8	19.3–22.0	20.5	1.2
Snout length	11.9	12.2	14.8	12.3	11.9–14.8	12.8	1.3
Eye diameter	12.1	12.8	12.9	12.3	12.1–12.9	12.5	0.4
Inter orbital width	9.3	9.1	9.9	9.1	9.1–9.9	9.3	0.4
Pre dorsal length	55.1	55.1	53.9	55.2	53.9–55.2	54.8	0.6
Post dorsal length	90.2	90.0	91.8	88.9	88.9–91.8	90.5	0.9
Pre pelvic length	49.9	51.1	51.8	50.9	49.9–51.8	50.9	0.8
Pectoral fin length	27.1	29.9	26.2	28.9	26.2–29.9	28.0	1.7
Pelvic fin length	25.2	25.7	22.4	23.1	22.4–25.7	24.1	1.6
Caudal fin length	25.1	23.8	23.3	22.8	22.8–25.1	23.7	0.9
Caudal peduncle length	30.0	31.1	31.9	30.8	30.0–31.9	30.9	0.8
Caudal peduncle depth	20.8	20.2	21.8	21.2	20.2–21.8	21.0	0.7
Anal fin length	20.1	20.8	19.0	18.2	18.2–20.8	19.5	1.2
Anal fin base length	12.9	12.0	12.1	12.2	12.0–12.9	12.3	0.4
Soft dorsal length	19.0	20.1	19.8	19.2	19.0–20.1	19.5	0.5

oblique mouth, elevated snout, longer lower jaw, maxilla reaching below the orbit, serrated limbs of preopercle, other bones of head and shoulders entire, large round black blotch at the end of caudal peduncle, first dorsal fin with 6 spines, membrane between 2nd and 3rd dorsal spines black, anal spines 2, lateral line scales 26 (Fig. 1). Munro (1955) described *A. thermalis* which agrees with the description of Day (1878). Lateral transverse scales are 2/7 in the present specimen, but 2 1/2 / 7 1/2 in the specimen described by Day (1878) and 2–3/7–8 in the description of *A. thermalis* by Munro (1955). Caudal fin emarginate in our specimens agrees with Munro (1955), but Day (1878) described it as lobed. *A. hyalosoma* resembles fishes of the Family Ambassidae, especially *Parambassis thomassi* in its colour (creamy white), elevated snout, oblique mouth, longer lower jaw, and serrations on preopercle, and differs in large ctenoid scales *vs* cycloid scales; maxilla reaching hind end of orbit *vs* maxilla reaching below the middle of orbit; absence of spines on pre orbital *vs* presence of 7–8 spines on pre orbit; dorsal spines 6 *vs* 7; anal fin with 2 spines *vs* 3; emarginate caudal fin *vs* forked; and the presence of caudal spot *vs* its absence in *Parambassis*.

According to Allen *et al*. (2002) and Donaldson and Myers (2002), *A. hyalosoma* is an estuarine species whose adults inhabit mangroves and lower reaches of freshwater streams. It is nocturnal and carnivorous (Day 1878; Munro 1955). Specimens were also collected from mangrove areas at Vayalkara. This fish is known to the locals, is edible and eaten fresh, dried, or salted.

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12. FIRST REPORT OF THREE SURGEON FISHES (FAMILY: ACANTHURIDAE) FROM THE NORTH OF EAST COAST OF INDIA

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Introduction

The surgeonfishes (Family: Acanthuridae) are comprised of seven genera and about 81 species throughout the world (Kamla Devi and Rao 2003), of which only 18 species occur on the east coast of the Indian mainland (Barman *et al.* 2004, 2007, 2011; Chatterjee *et al.* 2000; Das *et al.* 2007; Goswami 1992; Krishnan *et al.* 2007; Manna and Goswami 1985; Mohapatra *et al.* 2007, 2013; Murty 2002; Talwar and Kacker 1984; Talwar *et al.* 1994; Varghese *et al.* 2011). Recently, during a survey of ornamental fish fauna from the east coast of India, we collected three species of surgeonfish, namely *Acanthurus auranticavus* Randall, 1956; *Acanthurus bariene* Lesson, 1831; and *Ctenochaetus striatus* (Quoy and Gaimard 1825) that had not been reported from the Indian mainland coast. From Indian waters, the three species have been reported only from the waters of the Andaman and Nicobar Islands (Rajan *et al.* 2011).

In this paper, we discuss the sites and methods through which the species were obtained, and provide morphometric measurements and details of the specimens of these three Acanthuridae species.

Material and Methods

The specimens were obtained by trawl net from the Digha Mohona coast of West Bengal and the Chandipur coast of Odisha, from 29–32 km from the coast.

After capture, the specimens were photographed, preserved in 10% formaldehyde solution. The taxonomic identification was carried out following Randall (1956). The specimens were deposited in the Museum of Marine Aquarium and Regional Centre, Zoological Survey of India, Digha.

The characteristics, key features, and distribution of the three species of surgeonfish collected are discussed below. For morphometric measurements, see Table 1.

Acanthurus auranticavus Randall, 1956: Orange-socket Surgeonfish (Fig. 1)

Material examined: 1 example; Standard Length (SL): 208 mm; Collection Site: Digha Mohana (21° 37.843′ N; 87° 32.827′ E), Date of Collection: 22.viii.2012; Registration No. MARC/ZSI/F2599.

Meristic formula: D: IX, 26; A: III, 24; P: 16; V: I, 5.

Characters: Body oblong, compressed, not very deep; body depth (BD) 2.03 to SL; covered with thick minute scales. Dorsal profile of head gradually sloping to snout; length of head (HL) 3.92 times to SL; snout not very short, moderate and its length 4.83 times in SL. Mouth terminal, not small, its width 3.21 times in HL; single series of numerous comb like close sets of teeth on both jaws with denticulated cutting

Table 1: Morphometric measurements and other details of the three Acanthuridae species

Characters	*Acanthurus auranticavus* (n=1, collected from Digha Mohana)	*A. bariene* (n=3, 2 specimens collected from Digha Mohana & 1 Specimen from Chandipur)	*Ctenochaetus striatus* (n=1, collected from Digha Mohana)
Standard Length (mm)	208	262–353	184
	% of Standard Length		
Head length	24.06	25.73–26.79	25.92
Body depth	49.03	46.03–47.70	45.92
Eye diameter	5.29	4.76–5.19	5.76
Interorbital space	9.13	9.88–10.79	10.54
Snout length	20.43	19.84–20.53	19.40
9th dorsal spine	15.86	13.65–15.26	–
3rd anal spine	14.42	15.26–17.46	17.39
Pectoral fin	26.46	22.93–23.17	26.35
Ventral spine	7.96	10.30–11.11	11.61
Ventral ray	23.79	21.60–21.98	23.47
Caudal peduncle depth	10.58	10.69–11.29	12.39
Caudal peduncle length	12.01	10.76–11.39	10.54
Caudal spine	9.15	7.29–8.26	9.45
	% of Head length		
Mouth width	35.96	37.01–38.46	44.12
Eye diameter	21.99	18.50–19.51	22.22
Interorbital space	37.98	36.89–39.48	40.67
Caudal peduncle depth	43.99	41.57–42.16	47.79
Caudal spine	38.06	32.14–34.89	36.47

edge; number of teeth on both jaws 19. Eye high on head, its diameter (ED) 4.52 times to HL; narrow, convex inter orbital space 2.77 to HL. Gill opening restricted to sides; anterior gill rakers 22 and posterior gill rakers 25; isthmus attached to gill membrane. Scales from gill opening to posterior end of caudal spine 225. Single continuous unnotched dorsal consisting of 9 spines and 26 soft rays; length of 9th spine 6.30 times to SL; anal fin with 3 spines and 24 soft rays; length of 3rd spine 8.32 times to SL. Pectoral fin rays with 16 rays and its length 3.74 times to the SL; ventral fin with 1 spine and 5 rays, length of ventral spine 8.48 times to SL and ventral fin length 4.16 to SL. Caudal fin lunate, caudal concavity 6.70 times in SL. Caudal peduncle depth 2.38 times to HL; bearing sharp scalpel-like spines on both sides which are 2.71 times to HL.

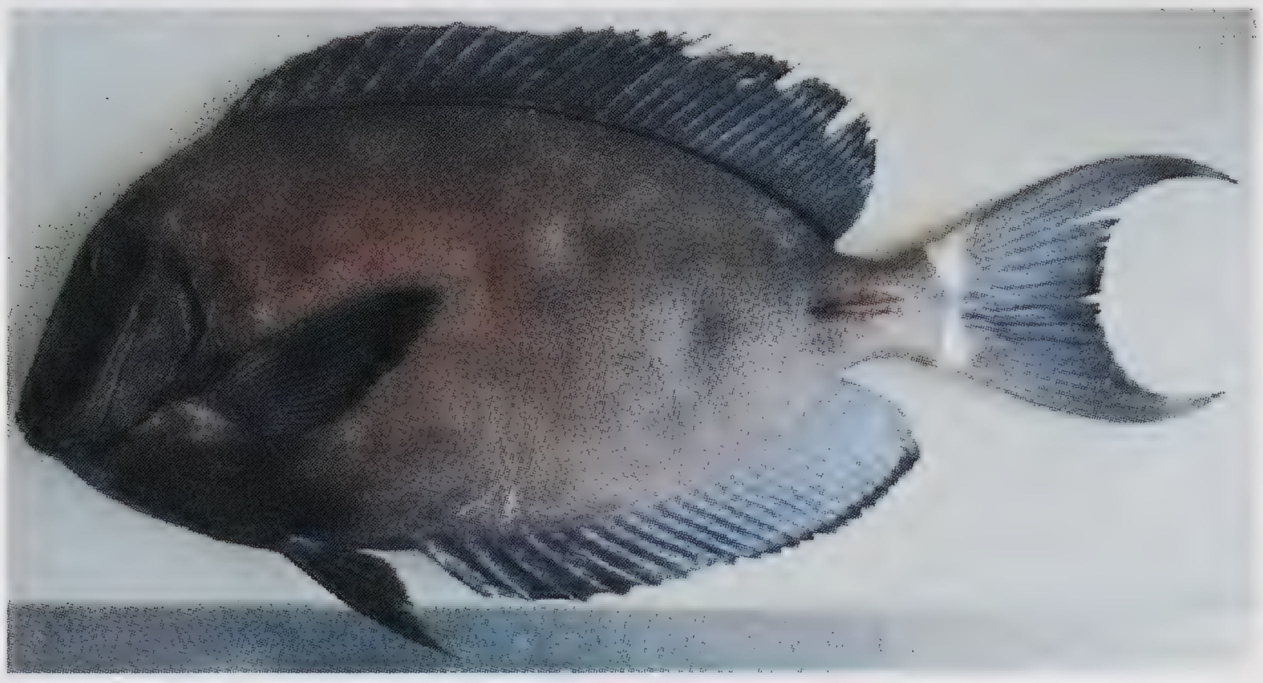

Fig.1: *Acanthurus auranticavus* Randall, 1956

Colour: Body dark brown with very narrow bluish wavy lines; a dark brown horizontally elongate spot at upper end of gill opening which is larger than eye diameter and tilting slightly downward posteriorly with a blunt end. Socket of caudal peduncular spine orange; dorsal fin brown and darker at base; anal fin more brown than dorsal; Pectoral fin light brown and ventral fin greyish-brown; caudal fin light brown with bright white bar at its base.

Distribution: This species is widespread in Indo-West Pacific, ranging from Seychelles (Randall and van Egmond 1994), Philippines, Indonesia and Great Barrier Reef, Maldives, Malaysia (Mohsin *et al.* 1993) and Samoa (Wass 1984); also found in Western Indian Ocean in Mozambique (Gell and Whittington 2002). In Indian waters, it has been reported only from Andaman and Nicobar Islands (Rajan *et al.* 2011).

Key features: Caudal spine socket is orange in fresh; dark brown shoulder mark narrow above gill opening and rounded below gill opening; caudal fin with bright white bar at its base; dorsal fin without bluish or yellowish band; dorsal fin IX, 25–26 anal fin III, 23–24; Posterior gill rakers 25–28.

Acanthurus bariene Lesson, 1831: Black-spot Surgeonfish (Fig. 2)

Material examined: 2 Specimens; SL: 262–315 mm; Collection Site: Digha Mohana (21° 37.843′ N; 87° 32.827′ E), Date of Collection: 12.i.2011 & 17.viii.2012; Registration No. MARC/ZSI/F2597 & MARC/ZSI/F2598; and 1 specimen; SL: 353 mm, Collection Site: Chandipur (21° 27.212′ N; 87° 03.064′ E), Date of Collection: 21.x.12; Registration No. MARC/ZSI/F2725.

Meristic Formula: D: IX, 28; A: III, 26; P: 17; V: I, 5.

Characters: Body oblong, compressed, its depth 1.98–2.04 to SL; covered with minute scales. Profile of head convex; its length 3.70–3.88 times to SL. Mouth terminal, its width 2.61–2.73 to HL; single series of fixed teeth on both jaws denticulated on entire margin with expanded incurved tips; 20 teeth on both jaws. Diameter of eye 4.90–5.69 to HL, convex interorbital space 2.41–2.72 to HL; snout moderate its length 4.71–5 times to SL. Gill membrane attached with isthmus; gill opening restricted to corner; number of anterior gill rakers 22–23 and posterior gill rakers 24. Scales from gill opening to posterior end of caudal spine 211–217. Single continuous dorsal fin with soft part having longer base than spinous part; dorsal spine 28 and soft rays 26; 9th dorsal spine 6.55–7 times to SL. Anal fin with three spines and 26 soft rays; posterior angle of anal fin pointed; 3rd anal spine 2.2–2.21 times to HL. Pectoral fin rays 17, its length 4.31–4.53 to SL; ventral fin with single spine its length 9–9.70 to SL and five rays, ventral fin rays 4.54–4.59 times to SL. Caudal fin lunate its concavity 5.72–6.55 to SL. Caudal peduncle depth 2.38–2.43 to HL; caudal peduncle with 1 folding spine 2.34–2.61 to HL.

Colour: Body brown with numerous irregular longitudinal pale blue lines. A black round spot about two-thirds of eye diameter present just above gill opening; margin of gill opening black. Dorsal fin yellowish-brown with a blue line at the base, and three bluish-violet margins at base. Anal fin brown with blue basal and marginal line. Pectoral fin blackish-blue with yellow bar near upper 2/3rd part; ventral fin blackish. Caudal fin light brown with yellow lobes.

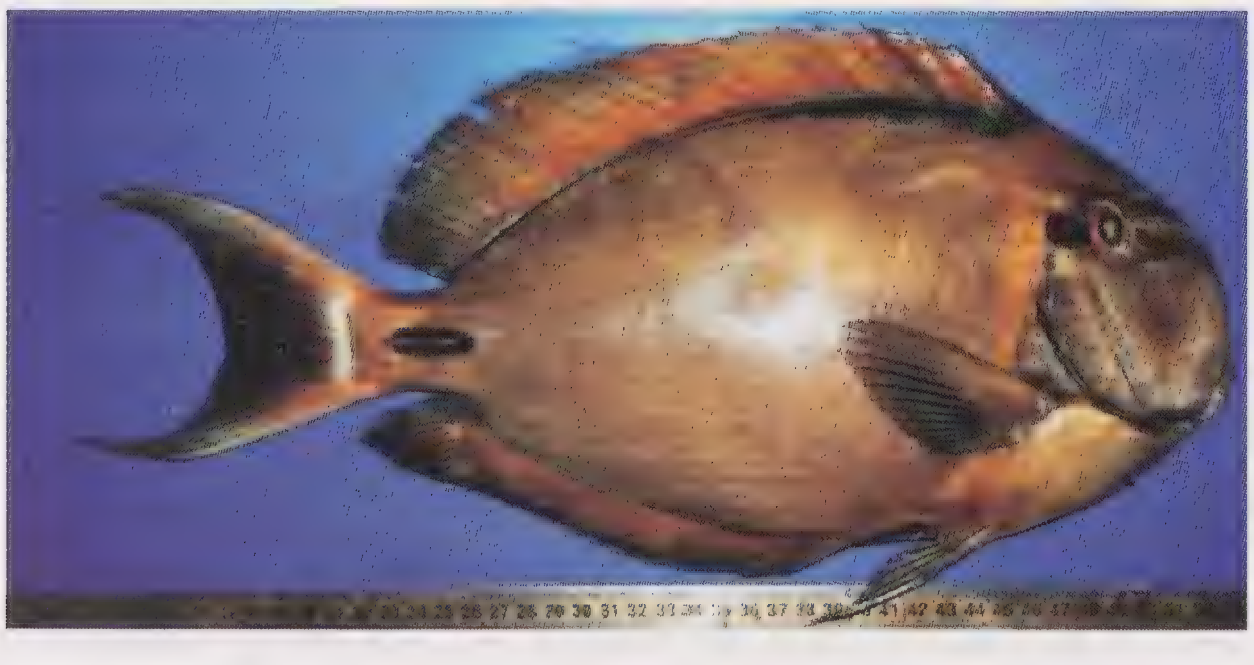
Fig. 2: *Acanthurus bariene* Lesson, 1831

Distribution: Indo-West Pacific: range from East Africa to the Riu Kiu Islands (Randall 1956). In Indian waters it is only reported from Andaman and Nicobar Islands (Rajan *et al.* 2011).

Key Features: Caudal spine socket black; dark shoulder mark as large as eye present just below the eye; dorsal fin with bluish border (white in preserved); dorsal fin IX, 26–28; anal fin III, 25–26; posterior gill rakers 22–24.

Ctenochaetus striatus (Quoy and Gaimard, 1825): Line bristletooth Surgeon (Fig. 3)

Material examined: 1 specimen; SL: 184 mm; Place of Collection: Digha Mohana (21° 37.843′ N; 87° 32.827′ E); Date of collection: 01.viii.12; Registration No. MARC/ZSI/ F2596.

Meristic formula: D: VIII, 29; A: III, 26; P: 16; V: I, 5.

Characters: Body ovate, compressed and covered with minute scales; body depth 2.17 in SL; head profile convex, HL 3.85 to SL. Mouth small, teeth numerous, movable and comb like with expanded incurved tips which are denticulate on the lateral margin; upper jaw with 5 denticulations and lower jaw with 4 denticulations. Snout straight and its length 5.15 to SL; interorbital space convex and 2.45 to HL; Eye diameter 4.5 to HL. Gill rakers 35 in anterior row and 39 in posterior row of first arch. Dorsal fin single, continuous and unnotched; anal and dorsal fin with pointed end. Pectoral fin 3.79 to SL; ventral fin 4.25 to SL. Caudal fin lunate; caudal concavity 5.2 in SL; depth of caudal peduncle 2.09 to HL

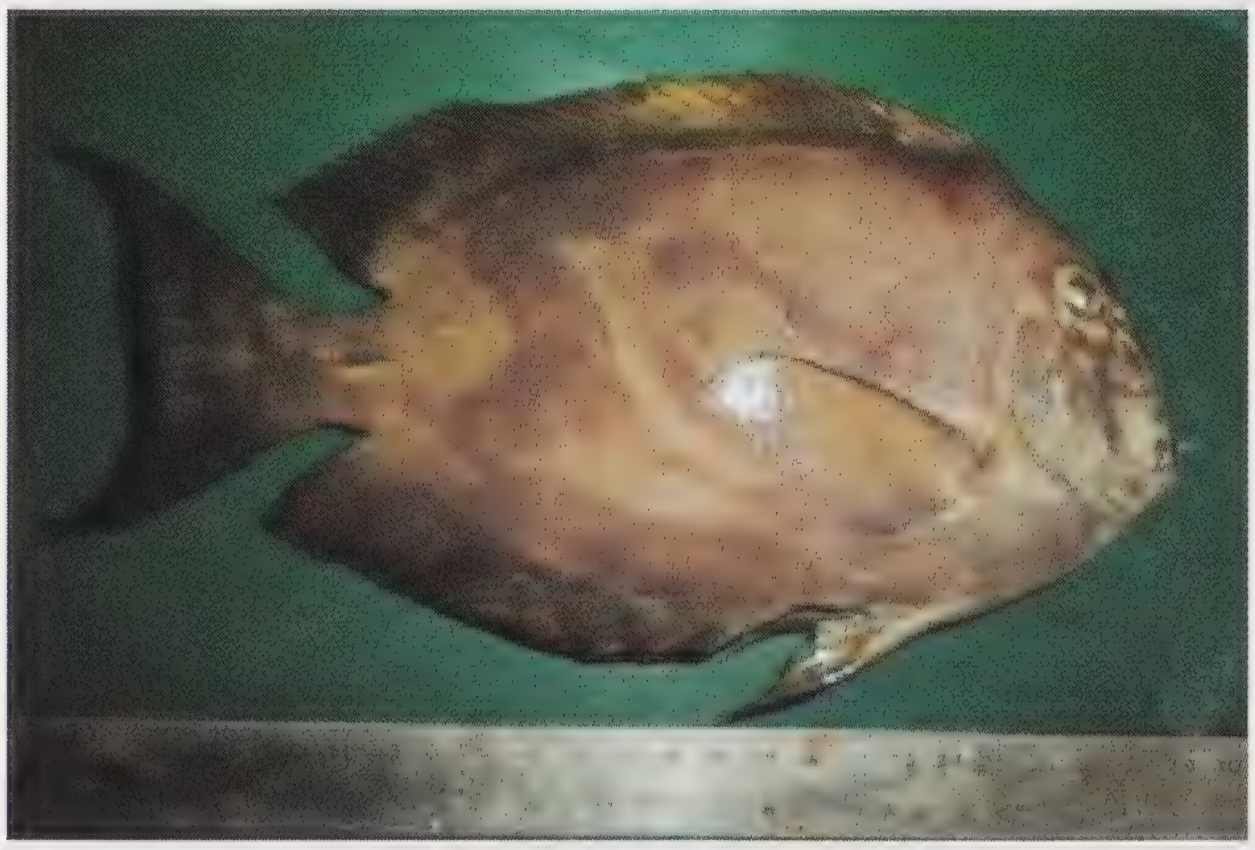
Fig. 3: *Ctenochaetus striatus* (Quoy and Gaimard, 1825)

and length of caudal peduncle 2.45 to HL; a lancet-like, sharp, forward directed spine present on each side of caudal peduncular horizontal groove, its length 2.74 to HL.

Colour: Body dark brown with blue lengthwise lines; small orange spots on nape and head; eyes surrounded by yellow border. Dorsal and anal fin with five lengthwise horizontal bluish bands; pectoral fins yellowish; ventral fin brown; caudal fin also brown but anterior part pale.

Distribution: Indo-West Pacific: throughout the region except Hawaiian, Marquesan and Easter islands; in western Indian Ocean; from Red Sea to Natal (Randall and Clements 2001). In Indian coastal waters, it is reported only from Andaman and Nicobar Islands (Rajan *et al.* 2011).

Key features: Caudal fin lunate; body, dorsal and anal fin with longitudinal blue lines; dorsal fin VIII, 29–30; anal fin III, 25–26.

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13. ON AN ABNORMAL SPECIMEN OF *LUTJANUS JOHNII* (BLOCH, 1792) (PISCES: PERCIFORMES: LUTJANIDAE) FROM WEST BENGAL COAST, INDIA

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Occurrences of abnormalities or deformities in fish have been reported in Indian waters and in other countries. As recorded by Gudger (1936), the case of abnormality in fish was first depicted in a figure during 1553.

Dawson (1964, 1966, 1971) and Dawson and Heal (1976) documented 1,499 references that described deformities in fishes. The reasons for such abnormal conditions range from genetic aberrations, pollution, environmental stress, abnormal growth or development of vertebral column, stunted growth, to accidental injury during the growing period of the fish (Bengtsson 1979; Evans and Neff 2009; Lemly 1997; Saha and Saha 2013; Sindermann 1976; Sun *et al.* 2009; Villeneuve *et al.* 2005). At one time, *Channa orientalis* was considered "as a series of abnormal specimens" (Myers and Shapovalov 1931) leading to the merging of two distinct species, i.e., *C. orientalis* and *C. gachua* (Mishra *et al.* 2013). The occasional absence of one or both of the paired fins is often reported (Hora 1921; James and Badrudeen 1968). Dorsal and anal fin deformities are also observed (Al-Mamry *et al.* 2010; Barman 1991), while regeneration of caudal fin is well-known (Akimenko *et al.* 2003; Patra and Dutta 2013; Shao *et al.* 2009). The absence of the entire caudal peduncle including caudal fin has not yet been reported.

During the course of the study on the fishes of the Family Lutjanidae, under the Order Perciformes from India by the first author, an abnormal specimen (Fig. 1b) was collected off Digha coast, West Bengal. In this specimen, the posterior part of the body behind the dorsal and anal fins was entirely lacking. A short description of the specimen is given hereunder, with a discussion on the probable reasons for the abnormality. The radiograph of the specimen (Fig. 2) was taken to study the osteological condition of the fish.

Lutjanus johnii (Bloch, 1792) (Fig.1a, b)

Anthias johnii Bloch, 1792, *Naturges. ausland. Fische,* 6: 113, pl. 318 (type locality: INDIA: Gujarat: Surat, Suratta).

Lutjanus johnii, Allen, 1985, *FAO Fish. Synop.*, (125) 6: 94–95.

Material Examined: ZSI F10732/2, 1 ex., 87 mm up to posterior end of dorsal fin; Off Digha coast, West Bengal; A. Das; 08.xii.2012.

Description of deformed specimen: Body moderately deep, with convex head profile. Head length slightly shorter than body depth. Eye diameter 4.0 times in head length. Suborbital width 1.64 times of eye diameter, and 6.57 times of head length. Interorbital width 5.75 times of head length. Preopercular notch and knob poorly developed. Vomerine tooth patch crescentric without posterior extension; tongue with a patch of granular teeth. Gill rakers 11 on lower limb of first arch (including rudiments). Maxilla extending below front border of the orbits. Dorsal fin continuous, not incised in between spinous and soft portions, with 10 spines and 13 soft rays. Anal fin with 3 spines and 8 rays. Soft parts of dorsal and anal fins rounded. Pectoral fins shorter than head length (1.31 times in head length) with 16 rays. Pelvic fin with one spine and 5 soft rays. Bases of both dorsal and anal fins with scales. Caudal peduncle and caudal fin entirely absent. Longitudinal scales rows on sides of body above and below lateral line horizontal or parallel to lateral line. Body bronze or reddish. All the fins yellowish in colour in live specimen. Each scale with a distinct brownish/dark spot forming the appearance of longitudinal scale rows on sides. A large black spot present above the lateral line, below front part of soft rays.

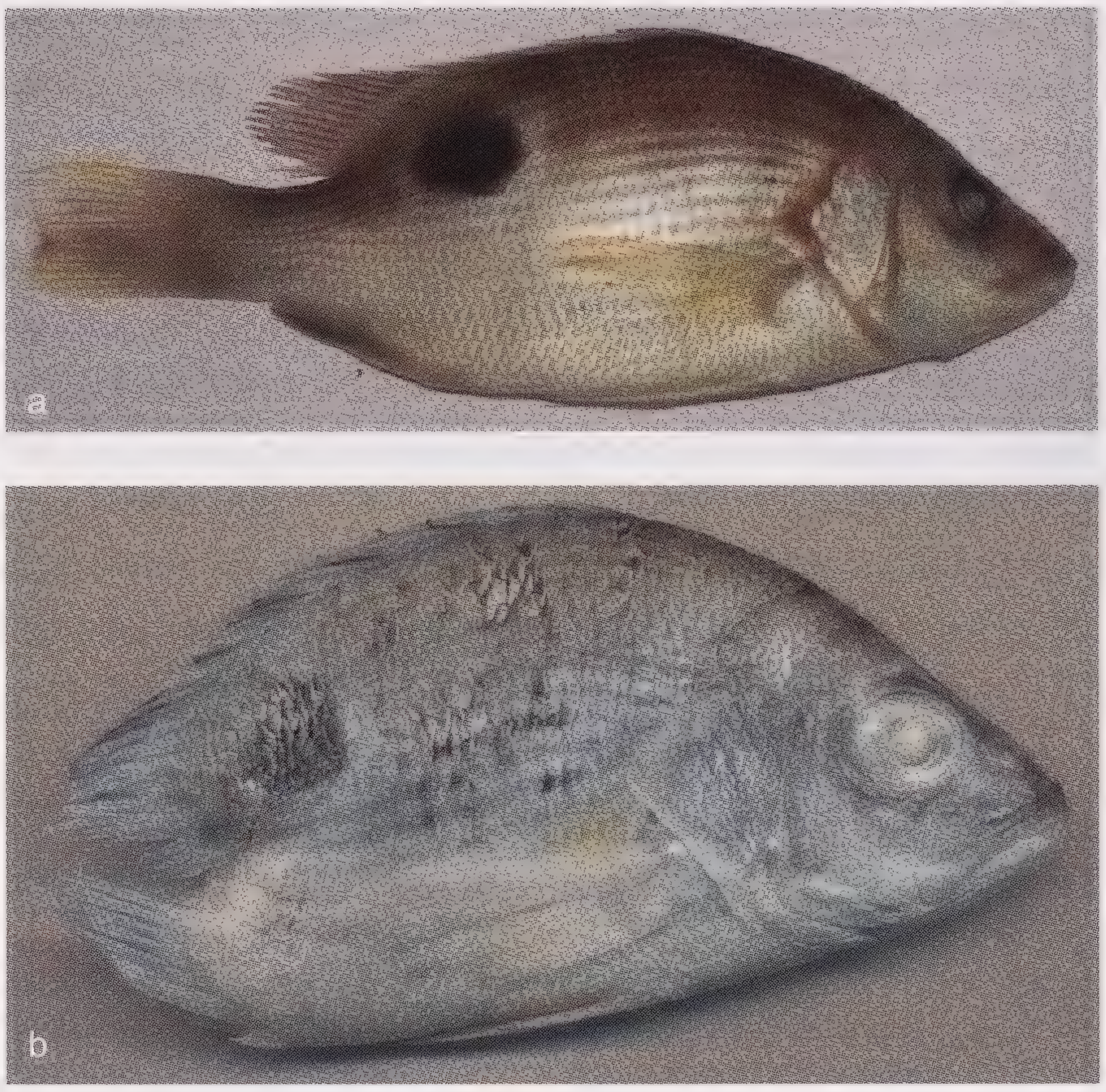

Fig. 1: *Lutjanus johnii* (Bloch): a. Normal (preserved specimen); b. Abnormal (preserved specimen)

From the radiograph (Fig. 2) it is evident that only 18 (10 + 8) vertebrae are present in this abnormal specimen, while all lutjanids normally have 24 (10 + 14) vertebrae (Nelson 2006). All 18 vertebrae are well-developed as compared with the radiograph of a normal specimen. Only the pterygiophores connecting dorsal and anal fin rays turned backward instead of remaining in slanting position as in normal fish.

Discussion

The body of the specimen does not show any fresh injury and it was sure to have died after being captured but not of injury. As the vertebral column is normal up to 18th vertebra and last 6 vertebrae are missing in the radiograph taken, it is obvious that the missing caudal peduncle is due to injury. Probably, the tail region would have been bitten off

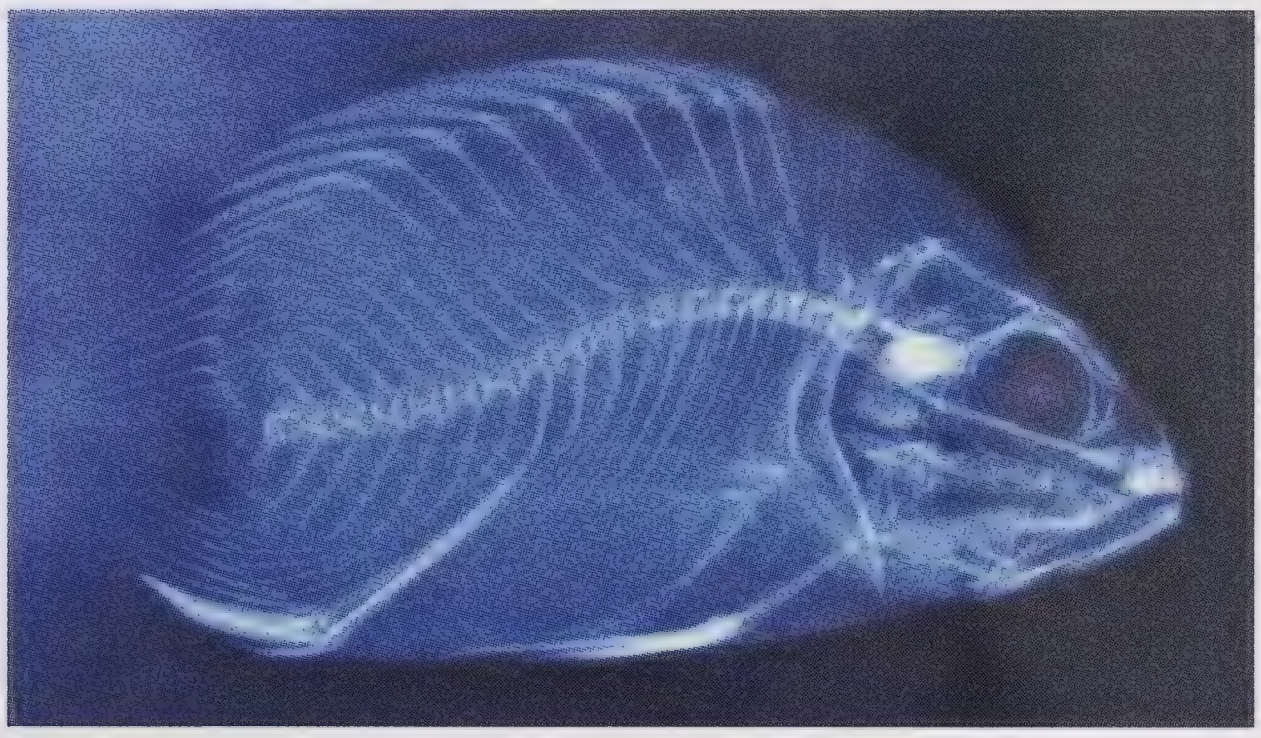

Fig. 2: Radiograph of abnormal specimen of *L. johnii*

by a predatory fish when this snapper was young, judging from the regeneration that had taken place.

Following the amputation, the posterior part of the body had not regenerated as usually happens if the caudal fin is cut off. All organisms have biological responses to damage, but these vary widely in the degree to which they can recover from damage. Homeostatic renewals are thought to be mediated by resident stem cells of specific lineages (Shao *et al.* 2009). Lower vertebrates such as fish have a remarkable capacity to regenerate complex structures damaged by injury or disease. This process, termed epimorphic regeneration, involves progenitor cells created through the reprogramming of differentiated cells or through the activation of resident stem cells (Stoick-Cooper *et al.* 2007).

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14. NEW RECORD OF LESSER BLUE WING *RHYOTHEMIS TRIANGULARIS* KIRBY, 1889 (ODONATA: LIBELLULIDAE) FROM ODISHA, INDIA

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The order Odonata is an important ancient group of insects and they are key indicators of water quality and fluvial ecosystem disturbance (Castella 1987). Fossil evidence suggests that the origin of this group dates back to the Permian era. Eight superfamilies, 9 families and some 58 subfamilies of dragonflies comprising 600 genera and 6,000 species of odonates are recorded (Subramanian 2009a,b) and Odisha harbours 110 species of odonates under 60 genera and 9 families (Nair 2011).

The study of the odonate fauna of Odisha was mainly carried out by Laidlaw (1915), Fraser and Dover (1922), Srivastava and Das (1987), Mitra (2002), Sethy and Siddiqui (2007), Das *et al.* (2010, 2011, 2012), Nair (2011), and Debata *et al.* (2013). Perusal of literature shows that *Rhyothemis triangularis* has not been reported hitherto from Odisha state.

The Lesser Blue Wing *Rhyothemis triangularis* was sighted on April 07, 2012, from Odisha during an Odonata survey in Kotagarh Wildlife Sanctuary. The species was found in the core area of the Sanctuary in Balliguda forest division near Dupi waterhole (19.89° N; 83.66° E). The terrain is flat with mixed forest.

Description

Rhyothemis triangularis belongs to family Libellulidae having medium-sized metallic blue-green wings with metallic markings on the base of the wings. The thorax is metallic blue-green and wings opaque metallic blue, while the remaining area is transparent (ed.: photographic evidence provided).

Field Diagnostic Features: Head: labium, labrum, and face black; frons and vesicle dark green or metallic greenish blue; occiput black; eyes blackish brown above; Prothorax blackish brown; Thorax dark metallic green. Legs, abdomen, and anal appendages are entirely black. Wings hyaline enfumed with pale brown, uniform in tint or gradually depending towards apices, bases of all black with dark metallic blue reflex, in forewing as far distal as second or third antenodal nervure and thence in a ragged line to posterior border of wing near the region of apex of anal loop; Pterostigma dark reddish brown colour and very short.

Distribution: The species distribution earlier ranged from India to south China and south to Java. In India, it is found in Assam, Karnataka, Kerala, and Tamil Nadu (Dow and Sharma 2010).

Conservation Status: This species is placed in Least Concern category in the IUCN Red List.

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15. SPECIES DIVERSITY OF BUTTERFLIES (INSECTA : LEPIDOPTERA: RHOPALOCERA) ON TWO TREES OF SOUTH ANDAMAN, INDIA

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I received news of butterflies on a tree *Ligustrum glomeratum* (Family Oleaceae) in the office premises of Central Agricultural Research Institute (CARI), Port Blair, South Andaman in August, 2007. On visiting the site I was amazed to see 300 to 350 butterflies comprising 19 species (Table 1) hovering over the tree in full bloom. Some of the butterflies were photographed. Two species of day flying moths were also recorded flying among the butterflies. This

Table 1: Butterflies recorded feeding on two tree species at Port Blair, South Andaman

S. No	Butterfly species	*Ligustrum glomeratum* (Family: Oleacae) August, 2007	*Premna integrifolia* (Family : Verbenacae) July, 2010	Status
	Family: Papilionidae			
1	*Pachliopta aristolochae goniopeltis*	Male	Male, Female	R
2	*Papilio mayo***	-	Male	R
3.	*P. polytes stichioides*	Male	Male, Female	C
4	*Graphium agamemnon andamana*	-	Male, Female	R
5	*G. eurypylus macronius***	Male	-	R
	Family: Pieridae			
6.	*Leptosia nina nina*	Male, Female	-	C
7	*Delias hyparete indica*	Male, Female	-	C
8	*Cepora nerissa dapha*	-	Male, Female	C
9	*Appias libythea olferna****	-	Male, Female	NR
10	*A. albina darada*	-	Male, Female	NR
11	*Ixias pyrene andamana*	-	Male, Female	NR
12	*Hebomoia glaucippe roepstorfii*	-	Male, Female	NR
13	*Catopsila pomona*	Male, Female	Male, Female	R
14	*C. pyranthe*		Male, Female	R
15	*Eurema hecabe blairana*	Male, Female	Male, Female	C
	Family: Lycaenidae			
16	*Nacaduba pactolus andamana***	-	Male, Female	NR
	Family: Nymphalidae			
17	*Parthenos sylvia andamana***	Male, Female	Male, Female	NR
18	*Neptis hylas andamana*	-	Male	C
19	*Hypolimnas bolina*	Male	Male	R
20	*Doleschallia bisaltide andamanensis**	Male, Female	-	NR
21	*Junonia hierta magna*	Male, Female	Male, female	C
22	*J. a. almana*	Male, Female	Male, Female	C
23	*J. atlites*	Male, Female	Male, Female	C
24	*Atella alcippe andamana*	-	Male, Female	NR
25	*Vindula erota pallida*	Male	Male	C
26	*Algia fasciata*	Male, Female	-	VR
27	*Cethosia cyanae*	-	Male, Female	C
28	*Euploea a. andamana*	Male, Female	Male, Female	NC
29	*Mycalesis visala andamana*	-	Male, Female	C
	Family: Hesperiidae			
30	*Tagiades japetus ravina*	Male	-	NR
31	*Notocrypta p. paralysos*	-	Male	R
32	*Cupitha purreea*	Male	-	NR

Species protected under WildLife (Protection) Act, 1972: * in Schedule I, ** in Schedule II and *** in Schedule III; C- common, R- rare, VR- very rare, NR- not rare.

phenomenon continued for about two weeks and gradually, as the flowers dried, the butterfly numbers came down and they finally left the spot.

A similar observation was made in the campus of J.N. Government College, Port Blair in July 2010. This time, the tree species was *Premna integrifolia* (Family Verbenaceae). The number of butterflies observed flying varied from 100 to 150, comprising not less than 27 species (Table 1).

Ligustrum glomeratum is a small evergreen tree. The inflorescence is a terminal panicle of cyme (Parkinson 1972). *Premna integrifolia* is a small tree. The presence of large congregations of butterflies species on these two tree species suggests that secondary forests can provide important food resource for butterflies. Such an observation was also made by Sondhi (2009) in Dalhousie, Himachal Pradesh, on Butterfly Bush *Buddleia davidii*.

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16. A NOTE ON THE OCCURRENCE OF *STERNASPIS SCUTATA* (RENIER 1807) – A STERNASPID POLYCHAETE FROM SUNDARBAN MANGROVES, WEST BENGAL, INDIA

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Sternaspis scutata belongs to Phylum Annelida, Order Canalipalpata and Class Polychaeta. Members of Family Sternaspidae were first recognised in the 16th century and formally described in the late 1810s (Ranzani 1817). They are commonly called Mud Owls because their large, stiff, ventral shield resembles two large eyes and the plump, peanut-shaped body completes the resemblance. Sternaspids are mostly shallow water forms, and a few deepwater forms also occur in the estuarine and mangrove environments. A total of 640 no./sq. m of the polychaete *Sternaspis scutata* were recorded by the authors in the core area of Sundarban mangrove region during June 2012.

Sediment samples were collected using Petersen grab (0.1 sq. m area) from Sundarban Mangroves, West Bengal (21° 42′ 705′ N; 88° 18′ 145″ E) during June 2012 (Fig. 1). The area mostly comprised muddy sand.

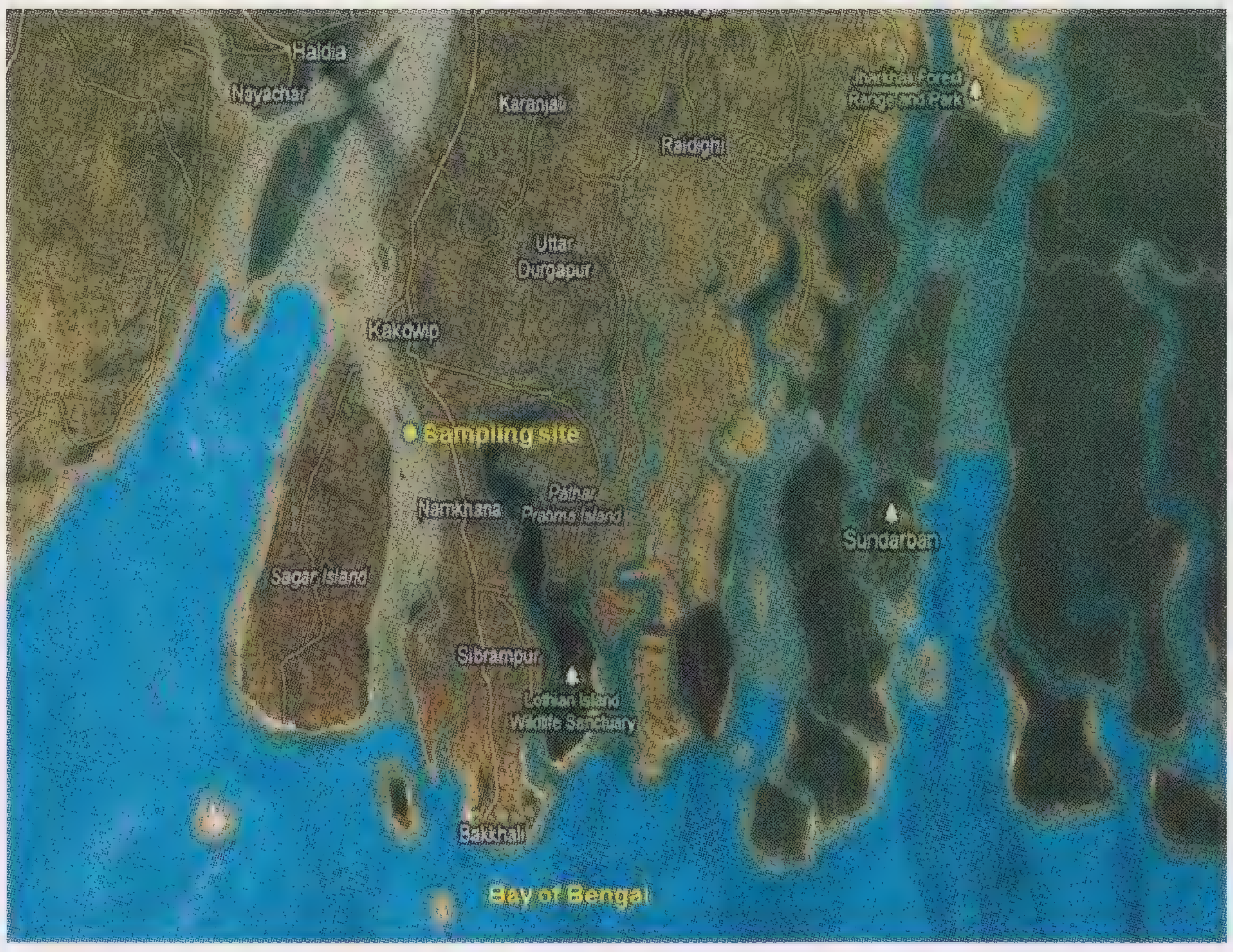

Fig. 1: Map showing the study area

Sternaspidae comprises a single genus *Sternaspis*, in which about 10 species have been reported by Fauchald (1977) and subsequently 12 valid species by Hutchings and Fauchald (2000). According to Petersen (2000), Sternaspidae is a monogeneric family of polychaetes with 13 nominal species and two subspecies. Recently, Sendall and Salazar-Vallejo (2013) recorded two new genera in this family. However, one or two species are recorded from many different localities and they are regarded as cosmopolitan (Hartman and Reish 1950). All *Sternaspis* species are typically sublittoral, marine, infaunal and non-selective, direct deposit feeders. Since the first record in the literature in the mid-1700s (Plancus 1760), members of this genus have been reported from all oceans of the world. Although they have been collected from depths as great as 4,418 m (Kirkegaard 1983), they are more likely to be collected from depths less than 200 m (Fauchald 1977). In Australia, one species of *S. scutata* has been recorded off the south Australian coast (Benham 1916). Records from

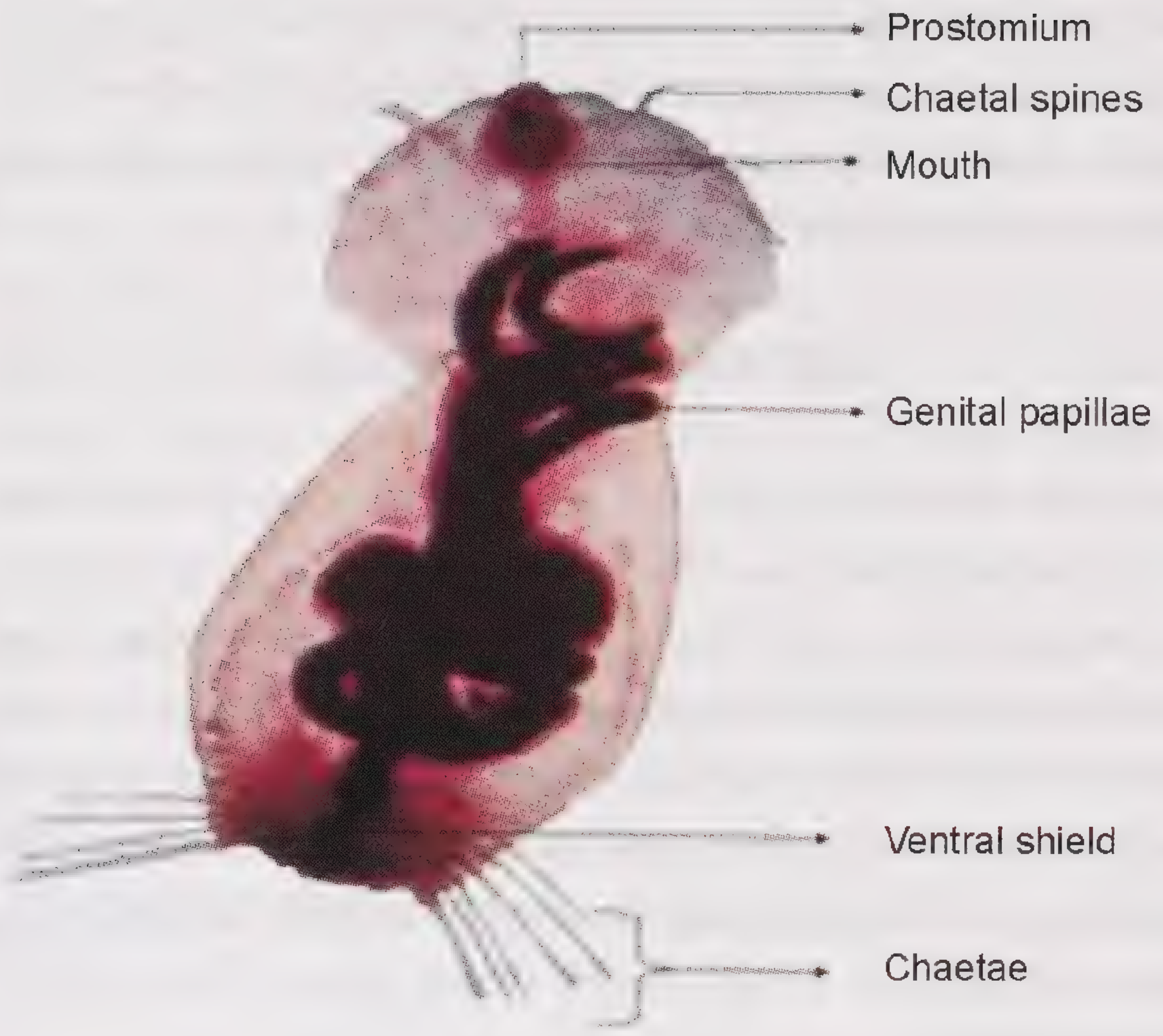

Fig. 2: *Sternaspis scutata*, entire worm

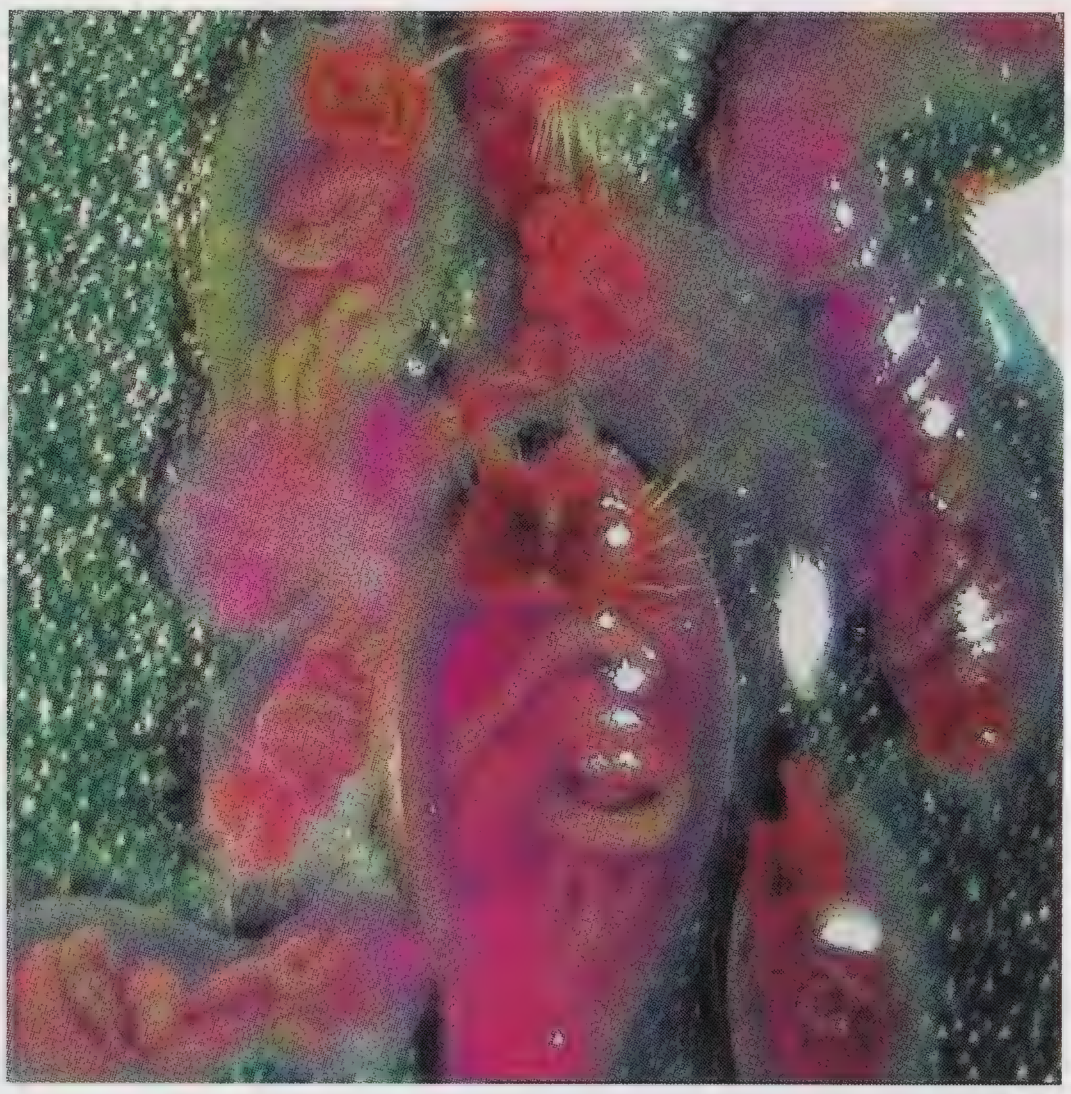

Fig. 3: *Sternaspis scutata* (ventral view)

the Australian Museum database indicate that a species of *Sternaspis* occurs at Sandy Cape, Rottnest Island, Western Australia. Sternaspids occur mostly in sandy and muddy substrate in all depths, but are usually found at depths of 100–200 m, rarely in large numbers (Fauchald 1977). They are easily recognised in sediment samples by their characteristic dark yellow to reddish chitinized shield. Although only the type species, *S. scutata* (Renier 1807), has been reported as cosmopolitan from the Arctic to the Antarctic in shallow to great depths (Day 1967), in reality several other species may be present.

Sternaspis scutata is described as follows: A stout burrowing worm, with leathery texture; body up to 35 mm long, 18 mm wide, divided into 30 segments, the first seven segments forming the anterior region and the remaining segments forming the posterior region; anterior region much smaller and narrower than the posterior region into which it can withdraw; head reduced, bearing a small, translucent, rounded prostomium above the mouth (Figs 2 and 3). The first segment a peristomium that is covered by short papillae. Prostomium hemispherical, without eyespots, opalescent, translucent; peristomium rounded, flattening at the position of the mouth, devoid of papillae. Mouth circular, completely covered with minute papillae, extends from behind the head forms prostomium to edge of second segment. Genital papillae protrude ventrally from body wall between segments 7 and 8. Pre-shield region with 7 segments, sometimes bearing a bundle of small, short, fine capillary chaetae laterally. Shield plate divided into two unequal parts by a slanting line and marked with ridges and striae. Ventro-caudal shield flat, ribbed with concentric lines; suture restricted to anterior region. Anterior margins truncate, straight; anterior depression deep; anterior keels not exposed. Lateral margins straight, not expanded medially. Fan smooth, markedly projecting beyond posterior corners, with margin smooth, barely crenulated. Marginal shield chaetal fascicles include 10 lateral ones, chaetae in an oval arrangement; six posterior fascicles, chaetae in a slightly curved arrangement.

Sternaspids are deposit feeders. According to Dales (1963) they lie head down, just under the surface of the mud, with the branchiae on the sediment surface of the mud, presumably to enhance oxygen exchange. The septa have mostly broken down and the gut is greatly coiled, in order to maximize the adsorption of nutrients. The simple, eversible axial pharynx helps to scoop up the sediment.

S. scutata ingests mainly fine sediment particles and thus increases the organic content of material in the gut over the content of sediment on which it feeds. The fine fraction has a high organic content because i. fine inorganic particles have a high surface area for adsorption of organic matter, and ii. most organic particles in the sediment are fine.

In a separate study, this species, which is non-native to the given area, rapidly expanded its range in inshore muddy sediments along the coast of the temperate region. Therefore, to determine the impact that the arrival of this moderately large infaunal deposit feeding polychaete could have on benthic biodiversity and ecosystem function, a mesocosm experiment was initiated elsewhere. It was concluded that despite its size, the relative immobility of *S. scutata* dictates that its presence has little impact on the species around it. The addition of this species did significantly reduce the release of nitrite (NO_2^-) and increase the release of ammonium (NH_4^+) from the sediment (Rachel *et al.* 2008). Therefore, the occurrence of this species is to be viewed with caution.

Presently we have collected 640 no./sq. m individuals of

S. scutata, which is uncommon in the mangrove environment. Similarly, Joydas and Damodaran (2009), while studying the benthic diversity in the continental shelf region of Arabian Sea (200 m depth), reported *Sternaspis scutata* as one of the dominant species, which is worthy of note.

Further, they have found that the species number, total biomass, and total numerical abundance exhibited progressive decrease with increasing depth. Likewise, Pillai (2001), while studying the benthic polychaetes from Cochin estuary reported as many as 30 species of polychaetes, of which *Sternaspis* sp. constituted a major proportion in terms of occurrence.

The present study provides only the qualitative list of occurrence of *S. scutata* in Sundarbans, West Bengal, which has high marine faunal diversity. An attempt is being made to quantify the data as this species has been recorded in exceedingly large numbers. An attempt is being made to relate the water and sediment parameters to the abundance of this species since sedimentary organic carbon might play a key role in its distribution.

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17. *PLAGIOCHILA DUTHIANA* STEPH. – A POORLY KNOWN SPECIES DISCOVERED FROM WESTERN GHATS, INDIA

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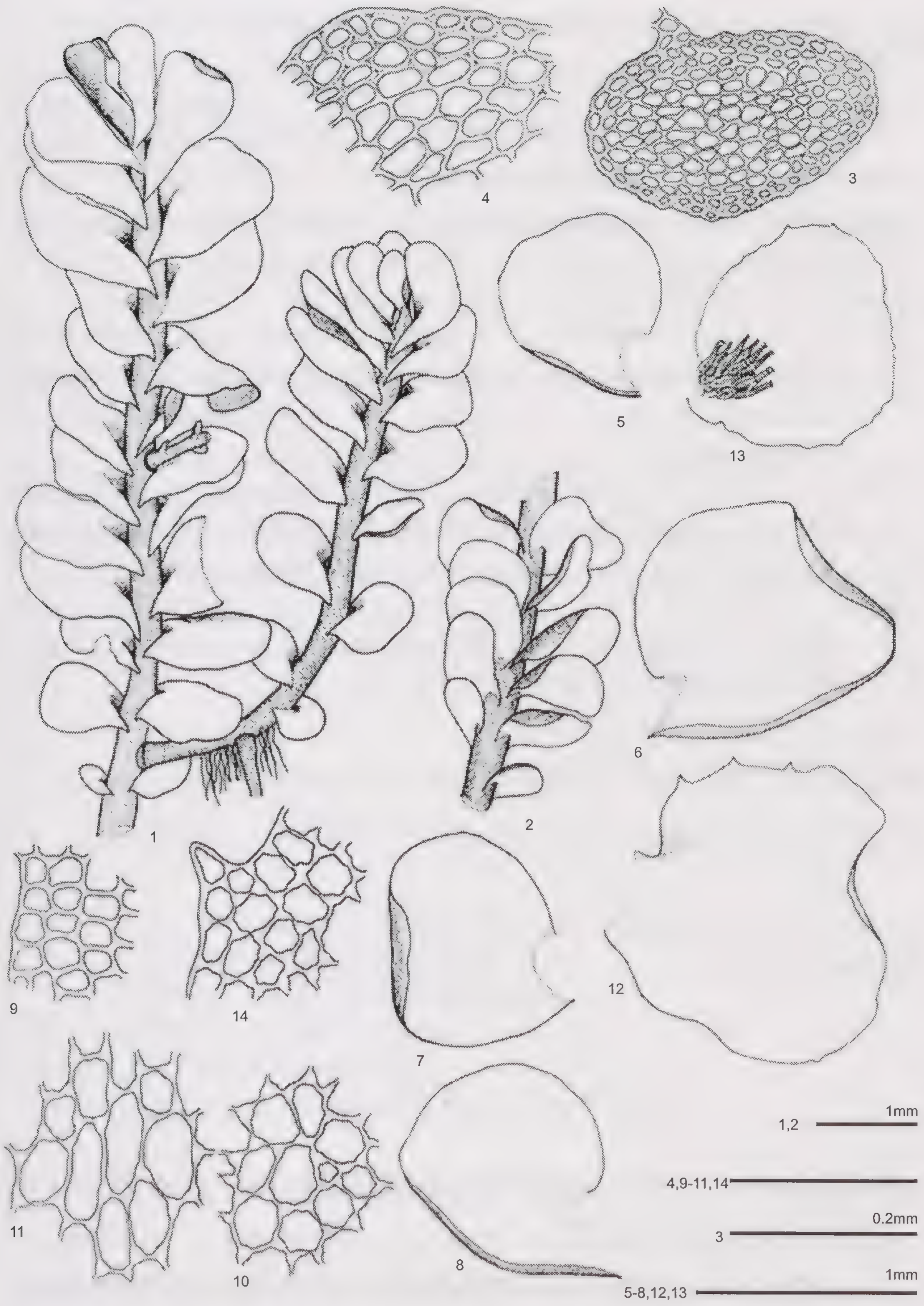
Introduction

Plagiochila (Plagiochilaceae) is one of the most common liverwort genera in the Nilgiri hills of Tamil Nadu as well as in India (Srivastava *et al*. 2002, 2007; Verma 2005; Verma and Srivastava 2008). The genus is characterised by: a simple to vigorous plant, sparsely branched with dichotomous to dendroid branching habit; stem typically differentiated into thick-walled cortical and thin-walled medullary cells; leaves always alternate, succubus, and usually toothed, rarely entire or with very small teeth as in *Plagiochila duthiana*, sub-transversely to obliquely inserted; perianth inflated, dorso-ventrally compressed, usually campanulate or with truncate mouth. Owing to enormous plasticity in morphological characters, *Plagiochila* is considered as one of the most problematic genera among the liverworts, with about 1,800 names described so far from the world, out of which about 480 names were reported from Asia (So and Grolle 2000). In India, the genus *Plagiochila* is represented by more than 100 species distributed in the Himalaya, southern India, and Andaman & Nicobar Islands. Interestingly, Central India lacks any representation of the genus. Examination of some old herbarium samples from the Nilgiri hills has revealed the presence of *Plagiochila duthiana* Steph., a species so far known only from the Indian Himalayan region in Indian bryoflora, belonging to section *Poeltiae* Inoue, which is characterised by orbicular to oblong-ovate leaves with small marginal teeth that may be often absent, and cyathiform perianth. In India, this section is represented by two species, namely *P. duthiana* Steph. and *P. poeltii* Inoue. Discovery of *P. duthiana* from the Nilgiri hills, therefore, constitutes not only its range extension, but also the first ever report of the section *Poeltiae* from southern Indian territory.



Figs 1–14: *Plagiochila duthiana* Steph.: 1. A portion of the plant in dorsal view with basal rhizoids, 2. A portion of the plant in ventral view, 3. Cross section of stem, 4. A portion of the same enlarged, 5–8. Leaves, 9. Apical cells of leaf, 10. Median cells of leaf, 11. Basal cells of leaf, 12. A female bract, 13. A female bract subtending a group of archegonia, 14. Apical cells of female bract (All figures drawn from R. Udar & Party 60 S/ 1972).

Plagiochila duthiana Steph., Bull. Herb. Boissier. Ser. 2, 3: 527.1903 & Sp. Hepat. 2: 331.1903; So, Syst. Bot. Monogr. 60: 118.2001. *P. himalayensis* Steph., Bull. Herb. Boissier, ser. 2, 3: 527.1903 & Sp. Hepat. 2: 331.1903. *P. seminuda* Inoue, Hara, *Fl. E. Himalaya* 1: 520.1966. (Figs 1–14)

Plants in loose patches, light brown in colour, 20–35 mm long, 1.8–2.9 mm wide, sparsely branched, branching lateral intercalary. Stem 13–14 cells across the diameter, differentiated, cortical cells 3-layered, thick-walled, small, light brown, 8–17 × 8–17 µm, medullary cells thin-walled, large, 26–35 × 22–35 µm. Rhizoids arising from rhizomatous axis, restricted only at base. Leaves imbricate, appressed to stem, obliquely inserted, broadly ovate, 1.0–1.5 mm long, 0.91–1.4 mm wide, dorsal margin recurved, base short decurrent, apex broadly rounded, ventral margin strongly arched, margin entire or minutely toothed; teeth 1–2 cells long, 1–2 cells wide; apical leaf cells 15–22 × 22–30 µm, median leaf cells 26–34 × 34–38 µm, basal leaf cells 45–69 × 22–30 µm, cells trigonous.

Dioecious. Gynaecia terminal on main axis; female bracts much longer and more toothed than stem; leaves sub-orbicular 1.0–1.4 × 0.91–1.04 mm. Perianth cyathiform, mouth dentate; teeth 1–4 cells long, 1–2 cells wide at base. Mature sporophyte not seen.

Type locality: INDIA: Jammu & Kashmir (So 2001).

Range: Myanmar, China, India, Japan, Nepal, Pakistan, and Taiwan (So 2001; Wang *et al.* 2011).

Distribution in India: Eastern Himalaya: Meghalaya (Shillong); Western Himalaya: Jammu & Kashmir (Tragbal pass), Himachal Pradesh (Kullu), Uttarakhand (Mussoorie). southern India: Tamil Nadu [Nilgiri hills, Upper Bhavani (Avalanche)] (see also Inoue 1965; Kashyap 1932; Rawat and Srivastava 2007; Singh and Singh 2009; So 2001; Srivastava 1979; Stephani 1903).

Habitat: Plants growing in rough mats on base of angiosperm tree, mainly in diffused patches and not completely attached with substrate; occurrence very rare.

Characteristics of the species: 1. Leaves orbicular-ovate 2. Leaves entire to minutely dentate (teeth 1–2 cells long) 3. Gynaecia always terminal and cyathiform, mouth truncate.

Specimens examined: southern India: Tamil Nadu, Nilgiri hills – Upper Bhavani (Avalanche), *c.* 2,250 m, 02.x.1972, R. Udar & party 60 S/1972 (LWU).

Other specimen examined: *Plagiochila himalayensis* Steph. N.W. Himalaya: Kashmir, Bashar, 1200, May 1894, J.S. Gamble 24923 (G 011003: Typus).

Plagiochila duthiana Steph. was first reported from India (Jammu & Kashmir) on the basis of the collection of F. Duthie. Stephani (1903) also reported another species *P. himalayensis* Steph. Inoue (1965) synonymized *P. himalayensis* under *P. duthiana*. An examination of plants collected from Nilgiri hills – Avalanche by the late Prof. Ram Udar and his associates revealed the presence of this species in the Western Ghats. The presence of this species in Nilgiri hills shows a southward extension of range of distribution, not only of the species but also of the section *Poeltiae*. In its overall appearance, *P. duthiana* appears like a species of *Jungermannia* due to orbicular-ovate leaves, which are often entire.

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18. *BEGONIA INTEGRIFOLIA* DALZELL – AN ADDITION TO THE FLORA OF GOA, INDIA

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Introduction

A species of *Begonia* L. was collected during our visit to Goa state. It was found growing on walls and rock crevices on both sides of the national highway near Poinguinim, southern Goa. So far it was known from the states of Maharashtra, Karnataka, Tamil Nadu, and Kerala (Gamble 1919; Nair and Henry 1983; Nayar *et al.* 2006; Rao 2001; Sharma *et al.* 1984). However, in the present record, *Begonia integrifolia* Dalzell is reported for the first time from Goa. The identity of the species was confirmed by comparing the specimens with images of types deposited in the Herbarium of Trinity College, Dublin (No. TCD0017180 and TCD0017181).

***Begonia integrifolia* Dalzell** in Hooker's J. Bot. Kew Gard. Misc. 3: 230. 1851; C.B. Clarke in Hook. *f.*, Fl. Brit. India. 2: 648. 1879; J.S. Gamble in Fl. Pres. Madras 1: 546. 1919; T. Cooke Fl. Pres. Bombay 1: 584. 1967 (Repr.); N.C. Nair & A.N. Henry in Fl. Tamil Nadu1: 175. 1983; C.J. Saldanha in Fl. Karnataka 1: 289. 1984; B.D. Sharma *et al.* in Fl. Karnataka: analysis 116. 1984; K.M. Rao in Singh *et al.* Fl. Maharashtra State, Dicot 2: 77. 2001; T.S. Nayar *et al.* in Fl. Pl. Kerala. p.142. 2006.

A succulent herb, *c.* 20 cm high. Stem erect, branched, densely to sparsely covered with small white hairs. Root stock tuberous, tubers large, pea-like. Leaves simple, asymmetrical, obliquely ovate to lanceolate, obliquely cordate at base, acute at apex, minutely hairy on both surfaces, dark red beneath, margin serrate and finely ciliate, measuring 8–23 x 5–19 cm, petiolate; petiole pale to darker pink; stipule 6–12 x 3–7 mm, pinkish white, glabrous or glabrescent, persistent. Inflorescence axillary few-flowered cymes, peduncle glabrous, 6–9 cm long. Flowers white, unisexual, bracteate; bract broadly ovate, glabrous, 1.3 x 1.3 cm, pedicellate; pedicel 2–2.3 cm long, glabrous. *Male flowers*: Tepals 4, petalloid, white, outer 2 tepals larger than inner 2, 1–1.4 x 1.1–1.5 cm, broadly ovate, obtuse at apex; inner 2, ovate to lanceolate, 0.9–1.2 x 0.6–0.8 cm, glabrous. Stamens more than 100, basally connate, *c.* 2 mm long; filament 1 mm long; anther elliptic, 1 mm long. *Female flower*: Tepals 5, outer two larger than inner, 0.9–1.3 x 1–1.4 cm, white; inner perianth elliptic oblong, 0.8–1.1 x 0.4–0.45 cm; styles 2, bifid, linear, each stylodium bifurcates in the stigmatic region, stigmatic surfaces spirally twisted linear coiled, 2.2 mm long; ovary winged. *Fruit* capsule, 2 x 2 cm, 3-winged, one of them larger than the other two with slight protuberance at tip, glabrous with persistent style; seeds numerous, elliptic ovate, 0.4 x 0.2 mm, truncate and stalked at base, brown, very small with alveolate surface.

Flowering and Fruiting: August to September.

Specimens examined: Mukkali forest (Palghat), 24.viii.1966, *Vajravelu* 27810 (MH); Panathur (Cannanore), 29.vi.1980, *Ansari* 67896 (CAL); Poinguinim, 6.vii.2011, *M.M. Aitawade* 6 (SUK); and Ansighat, 6.vii.2011, *M.M. Aitawade* 7 (SUK).

Distribution: Southern India, Sri Lanka, Indo-China, Laos, Vietnam, Thailand, Malaysia.

Note: Many individuals are found to be growing in humid and shady places on walls and roadsides. This species can be distinguished by its pea-like tubers, leaves dark red beneath, flowers white, broadly ovate bracts, and 3-winged capsule of which one wing is larger than others. This species has potential as an ornamental and should be brought under cultivation.

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19. *ARTEMISIA SANTOLINIFOLIA* TURCZ. EX BESSER (ASTERACEAE) – AN OVERLOOKED SPECIES IN INDIAN FLORA

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During the course of identification of some of the collections of *Artemisia* species from Western Himalaya at the herbarium of CSIR-National Botanical Research Institute, Lucknow (LWG), the authors encountered eight quite old specimens of *Artemisia* L., which were collected on the way to Milam, presently in Uttarakhand state (four specimens collected by D.D. Awasthi on October 07 and 08, 1950, and the other four by J.G.S. Srivastava and party on November 08 and 09, 1959). These specimens were identified as *Artemisia sacrorum* Ledeb., and have been reported as common in their localities. Y.R. Ling, who was working on Chinese Artemisia had critically examined the said specimens and identified them as *Artemisia santolinifolia* Turcz. ex Besser. These specimens might have escaped the notice of recent Indian taxonomists, hence *Artemisia santolinifolia* remained unreported even in recent publications (Hajra *et al.* 1995; Uniyal *et al.* 2007). Quaiser (*l.c.*) has reported its distribution in Kashmir and Ladakh, that too without citing any precise locality for the plants. Hence, the present report is virtually a new distributional record of this species for the flora of India, and even otherwise it extends its distribution from Kashmir to the Kumaon region in eastern Uttarakhand. This species

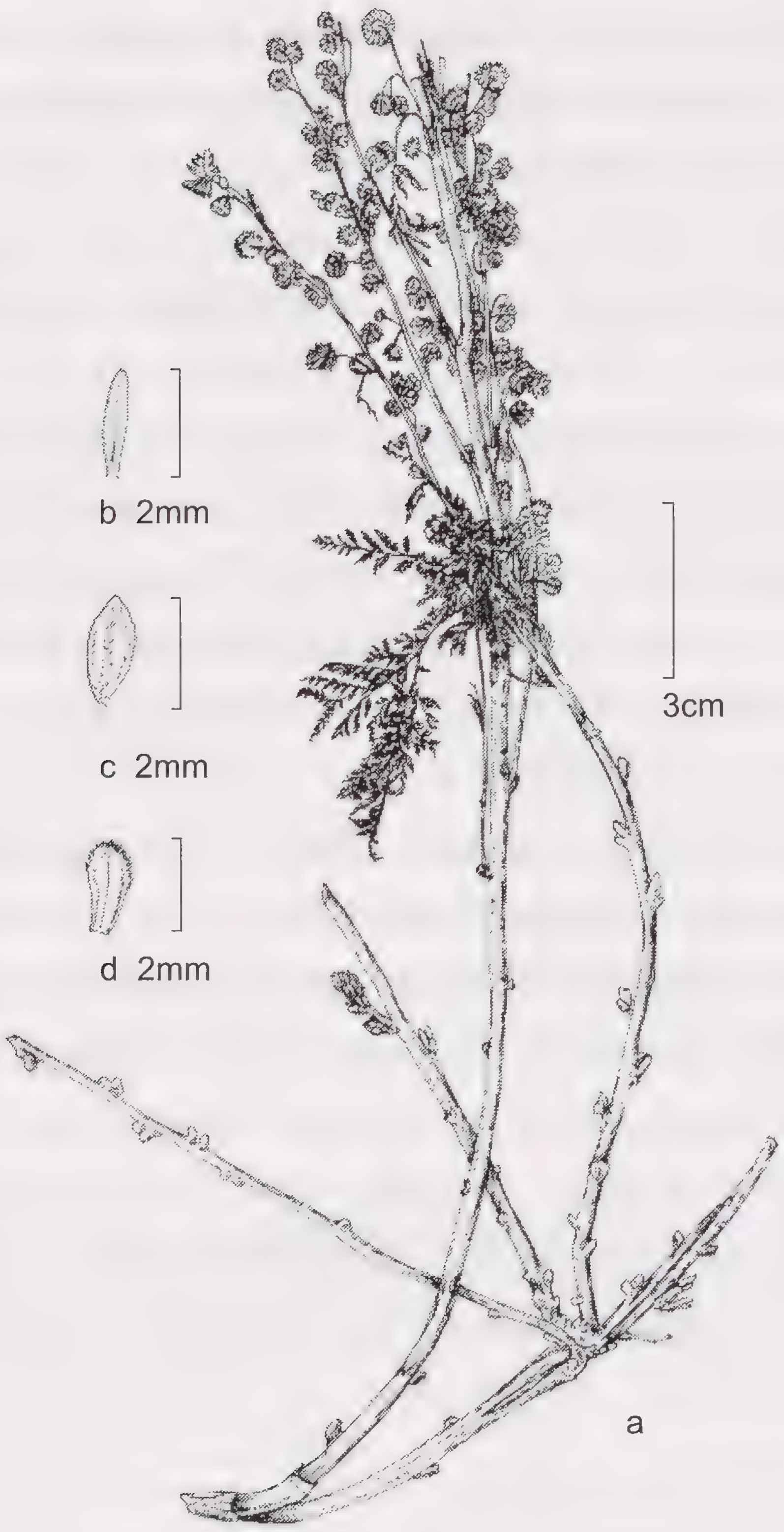

Fig. 1: *Artemisia santolinifolia* Turcz. ex Besser: a. Habit; b., c. & d. outer, median & inner involucral bracts

is not included in Hooker's (1881) Flora. Pertinent on-line plant taxonomic databases were also critically examined for background information on the taxon in question. A description along with nomenclature and illustration of this species is given below to facilitate its identification.

Artemisia santolinifolia Turcz. ex Besser in Nouv. Mém. Soc. Imp. Naturalistes Moscou 3: 87. 1834; Podlech in Rech. f., Fl. Iran. 158: 172. 1986; Quaiser, 'Asteraceae' in Fl. Pakistan 207: 139. 2008. *A. sacrorum* Ledeb. var. *minor* Ledeb., Fl. Alt. 4: 72. 1833. *A. sacrorum* var. *santolinifolia* (Turcz. ex Besser) Pamp. in Nuov., Giorn. Bot. Ital. n. s. 34: 693. 1927. (Fig. 1).

Perennial, erect, stiff herb, up to 1 m high. Stem basally woody, much branched above, 1.0–1.5 cm thick, sparsely pubescent to glabrous, grooved. Leaves 2.0–4.0 x 1.5–2.5 cm, ovate-triangular, sparsely hairy; lower 3-pinnatisect; uppermost leaves 1-2-pinnatisect or simple; ultimate segments 1.0–4.0 x 0.3–1.0 mm, narrowly lanceolate-linear; petioles up to 2.5 cm long. Heads subsessile, 3.0–5.0 mm across, in many-flowered, terminal, leafy, 20–40 cm long panicles. Involucral bracts 3-seriate; outermost 2.0–2.2 x 0.3–0.4 mm, linear-oblong, green, sparsely hairy; median *c.* 2.0 x 1.2 mm, elliptic, with widely scarious margins, laxily hairy along midrib; innermost obovate, equalling the median ones, scarious hyaline. Florets yellow, all fertile; marginal florets with *c.* 1 mm long, narrow, 2-toothed corolla tube; disc-florets with *c.* 1.2 mm long, 5-toothed, corolla tube. Achenes *c.* 1.0 mm long, brown.

Fl. & Fr.: August–November.

Ecology: Common on dry stony slopes with sandy-clay soils between Mirtoli and Milam, and on the way to Milam and Sanglikund in eastern Kumaon region, but this species has not so far been collected from other places.

Distribution: INDIA: W. Himalaya (Kashmir and Kumaon), 3,000–4,000 m; Pakistan, Afghanistan, Central Asia, Russian Federation, China, and Mongolia.

Specimens examined: Pithoragarh dist.: Between Mirtoli and Milam, Awasthi, 1872; on way from Milam to Sanglikund, Awasthi, 1875; on way to Milam glacier, Srivastava & Party, 52352, 52400.

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20. *PHYSALIS PRUINOSA* L. (SOLANACEAE) – A NEW RECORD FOR THE FLORA OF UTTAR PRADESH AND UTTARAKHAND, INDIA

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The genus *Physalis* L. comprises 75+ species of cosmopolitan distribution (Mabberley 2008). According to Deb (1980), six species of *Physalis* occur in India, namely *P. alkekengi* L., *P. angulata* L., *P. ixocarpa* Brot. ex DC., *P. virginiana* Mill. var. *sonorae* (Torr.) Waterf., *P. peruviana* L., and *P. minima* L., of which the former three species are cultivated whereas rest are adventive. Singh and Pandey (2002) added one more species, *P. maxima* Mill. to the list, as a new introduction to India. The hybridization among some of these species outside their native range poses ambiguity in their correct identification. Raju *et al.* (2007) discussed the status of *P. minima* and *P. maxima* and their alleged presence in the Indian subcontinent. According to them the name "*P. minima*" is misapplied to two different species, *P. angulata* and *P. lagascae* Roem. & Schult. The correct name of the widely known *P. minima* is *P. lagascae*. The name of "*P. maxima*" applied to the naturalized weed in the Indian subcontinent and elsewhere is to be substituted by *P. pruinosa* L., a name misapplied to *P. grisea* (Waterf.) M. Martinez. During field surveys in different parts of Garhwal Himalaya in Uttarakhand, some interesting specimens of *Physalis* were collected by one of us (SCS). Similar specimens were also collected from Lucknow. All the specimens were identified as *P. pruinosa*. A perusal of relevant literature (Khanna *et al.* 1999; Uniyal *et al.* 2007) revealed that the species is not hitherto reported from Uttar Pradesh or Uttarakhand states. So, it is reported here as a new record. Voucher specimens are deposited in the Herbarium of the Central Institute of Medicinal and Aromatic Plants, Lucknow (CMAP). A description along with nomenclature and a photograph of this species is given below to facilitate its identification.

Physalis pruinosa L., Sp. Pl. 1: 184. 1753; Martinez in Taxon 42: 104. 1993; Raju *et al.* in Acta Phytotaxon. Sinica 45(2): 243. 2007. *P. maxima* Mill., Gard. Dict. ed. 8, *Physalis* no. 15. 1768; Singh & Pandey in Ind. J. Forest. 25 (1-2): 187, f. 1(a-k), Pt. 1-2. 2002.

Annual, erect, stout, sticky, dichotomously branched herb with spreading branches. Stem 0.5–1.0 m high, subangular-terete, fistular especially in lower part, densely pubescent; hairs long and short mixed, 0.3–2.0 mm long, partly gland-tipped. Leaves alternate, 4.0–18 x 2.5–13.0 cm, broadly ovate, unevenly and prominently dentate to sinuate, shortly acuminate at apex, obliquely rounded to cordate at base, pubescent on both sides with both simple and gland-tipped hairs, midribs and lateral veins prominent with dense pubescence, light green; petiole 2–5.5 cm long, densely pubescent with rather longer hairs. Flowers solitary, axillary, 1.0–1.5 cm across, creamy white; pedicels 1.5–4.0 cm long, erect, nodding and elongated up to 7.0 cm in fruit, glandular-hairy. Calyx 5.0–9.0 mm long, campanulate, divided half way down, glandular-hairy; lobes 5, subulate, long acuminate, glandular-hairy on the margins. Corolla 1.0–1.5 cm long, campanulate, glandular pubescent, with 5 pale green glandular blotches on the throat; lobes 5, obscure. Stamens 5, glabrous; filaments 3.0–4.0 mm long, inserted on the tube; anthers 2.5–3.0 mm long, oblong, basifixed, yellow. Ovary globose, seated on a short disciform gynophore, glandular pubescent; style 3.0–4.0 mm long; stigma obscurely 2-lobed, green. Fruiting calyx 2.0–2.5 cm long, bladder-like, 5-angled with 5 short ridges between the expanded angles, reticulately veined, thinly pubescent along the angles, apex gradually narrowed to a beak-like tip. Berries enclosed within inflated calyx, 1.0–1.5 cm in diameter, globose, viscid, pale green; seeds many, *c.* 2.0 mm long, ovoid, granulate, white.

Fl. & Fr.: August–October

Ecology: Ruderal (growing on waste) along roads and waysides, preferably in moist fertile soil; not common, localized in small patches.

Distribution: Mexico and Central America; introduced into tropical Asia (INDIA: Andhra Pradesh, Rajasthan, and Tamil Nadu). Present report extends its distribution to Lucknow in Uttar Pradesh and to the Himalaya, up to 1,500 m (Byasi in Pauri Garhwal district and Pipalkoti in Chamoli district of Uttarakhand state).

Specimens examined: Uttar Pradesh: Lucknow, Janakipuram extension, 14.ix.2012, S.C. Singh 14556 (CIMAP); Uttarakhand: Pauri district, Byasi, 9.x.2012, S.C. Singh 11278; Chamoli district, Pipalkoti, 9.x.2012, S.C. Singh 12679 (CIMAP).

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CONTENTS

EDITORIAL 1

ROLE OF MOTHER AND ALLOMOTHERS IN INFANT INDEPENDENCE IN CAPPED LANGUR *TRACHYPITHECUS PILEATUS*
Awadhesh Kumar and G.S. Solanki 3

FORAGING BEHAVIOUR OF THE NEAR THREATENED GREY-HEADED BULBUL *PYCNONOTUS PRIOCEPHALUS* IN RELATION TO SEASONS AND BREEDING STAGES
P. Balakrishnan 10

THYSANOPTERA (INSECTA) FAUNA OF THE KEIBUL LAMJAO NATIONAL PARK, MANIPUR, NORTHEAST INDIA
K. Nishikanta Singh and R. Varatharajan 19

AEROBIC CULTURABLE BACTERIAL MICROFLORA IN RESIDENT *GYPS* VULTURE SPECIES OF INDIA
Rohan N. Shringarpure, Mandar D. Kulkarni, Chhaya Sawant, Ashok Bhagwat, Toby H. Galligan and Vibhu Prakash 29

OBITUARY 36

REVIEWS 38

MISCELLANEOUS NOTES 40

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VOLUME 111(2): AUGUST 2014

CONTENTS

EDITORIAL 71

MOLECULAR SEXING OF THE CRITICALLY ENDANGERED SLENDER-BILLED VULTURE *GYPS TENUIROSTRIS* AND ITS CONSERVATION IMPLICATIONS
Mandar Dilip Kulkarni, Rohan Shringarpure, Chandra Mohan S., Mohini Saini, Tapan K. Palai, Praveen K. Gupta, Purvi Bhatt, Nikita Prakash, Ashok Bhagwat and Vibhu Prakash 73

THE GRASSLAND BIRDS OF ROLLAPADU WILDLIFE SANCTUARY, ANDHRA PRADESH, INDIA, WITH SPECIAL REFERENCE TO THE IMPACT OF GRAZING-FREE ENCLOSURES
Ranjit Manakadan 81

FOOD HABITS OF INDIAN GREY HORNBILL *OCYCEROS BIROSTRIS* IN SATHYAMANGALAM FOREST DIVISION, EASTERN GHATS, INDIA
E. Santhoshkumar and P. Balasubramanian 90

NEW RECORD OF LIVE CORAL SPECIES COLONIZING INTERTIDAL ZONES ALONG SOUTHERN SAURASHTRA, INDIA
Paresh Poriya, Bhavik Vakani and Rahul Kundu 98

NEW RECORDS OF SEAWEEDS FROM THE GOA COAST, INDIA
N. Pereira and M.R. Almeida 106

REVIEW

NATURE CHRONICLES OF INDIA: ESSAYS ON WILDLIFE
Reviewed by Asad R. Rahmani 124

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MISCELLANEOUS NOTES

MAMMALS

1. A further record of Large Indian Civet *Viverra zibetha* Linnaeus 1758 from Odisha, India
Pratyush P. Mohapatra and Himanshu S. Palei 125
2. Mongoose rabies in Kannur, Kerala, India
E.A. Jayson and Suresh K. Govind 125
3. First record of Indian Long-eared Hedgehog *Hemiechinus collaris* from Dhaulpur, eastern Rajasthan, India
Rajeev Tomar and Rakesh Vyas 126
4. Observations of masturbation and consumption of ejaculate by Five-striped Palm Squirrel *Funambulus pennantii*
Anuj D. Raina 127

BIRDS

5. The Malayan Night-Heron *Gorsachius melanolophus* in Mount Harriet National Park, Andaman Islands
Harkirat Singh Sangha 128
6. First record of Greater White-fronted Goose *Anser albifrons* (Scopoli, 1769) Amravati, Maharashtra, India
Ashahar Khan, Manoj Bind and Ahsan Sheikh 129
7. First report of Long-billed Plover *Charadrius placidus* from Maharashtra, central India
Kiran Morey, Ninad Abhang, J.S. Wadatkar, G.A. Wagh and G.S. Kadu 130
8. Sighting of a flock of leucistic Black-tailed Godwit *Limosa limosa* in Chilika lake, Odisha, India
Monalisa Bhujabal and Nanda Kishore Bhujabal 131
9. Records of Ibisbill *Ibidorhyncha struthersii* in the Bhagirathi river, Harsil, Uttarakhand, India
Ankita Sinha, Tanvi, B.S. Adhikari and K. Ramesh 132
10. Mountain Imperial-Pigeon *Ducula badia* (Raffles) feeding on *Caesalpinia pulcherrima* (Fabaceae) flower buds
Anilkumar, S. 133
11. First report of Forest Owlet *Heteroglaux blewitti* from Tansa Wildlife Sanctuary (Western Ghats), Maharashtra, India
Sunil Laad and Rohidas Dagale 134
12. Unusual congregation of Savanna Nightjar *Caprimulgus affinis* in a wheat field
Girish Jathar, Sachin Anpat, Balu Bhangare and Dharmaraj Patil 135

REPTILES

13. Indian Spiny-tailed Lizard *Saara hardwickii* in Sariska Tiger Reserve, north-eastern Rajasthan, India
Manoj Parashar, Dibyendu Mandal, Pooja Chourasia and K. Sankar 136
14. Photographic record and field observations of a Brown-spotted Pit Viper
Bhattacharjee, K. 137

FISH

15. On a report of Red-bellied Pacu *Piaractus brachypomus* (Cuvier, 1818), (Characiformes: Characidae) from Muvattupuzha river, Kerala, India
K.V. Zeena and K.S. Jameela Beevi 138
16. Ichthyofaunal diversity of Tundi wetland, Bajana, Little Rann of Kachchh, Gujarat, India
H.S. Banyal and Sanjeev Kumar 140

INSECTS

17. *Yucca decipiens* Trel., a new host of Florida Red Scale *Chrysomphalus aonidum* L. in India
B.A. Kore and Thite, S.V. 144
18. Mass occurence of Stink Bug *Cyclopelta siccifolia* (Westwood) (Heteroptera: Pentatomoidea: Dinidoridae) on *Millettia pinnata* (L.) Panigrahi, at Kannur, Kerala, southern India
Vinayan Nair 146

BOTANY

19. *Solanum sisymbriifolium* Lam. – an addition to the flora of Jharkhand, India
S.P. Panda, H.K. Sahoo, A.K. Sahu and H.N. Subudhi 147

20. *Ficus variegata* Blume (Moraceae) – a new record from Arunachal Pradesh, India
Rubul Buragohain, P.R. Gajurel, P. Rethy and B. Singh 148

21. Smilacaceae in Darjeeling and Sikkim Himalaya, India
A.K. Samanta and Sauris Panda 149

22. *Digitaria radicosa* (J. Presl) Miq. and *Pennisetum purpureum* Schumach. – additions to the grass (Poaceae) flora of Manipur, India
Kangjam Tilotama Devi, Potsangbam Kumar Singh and Debjyoti Bhattacharyya 153

23. *Pteris biaurita* L. (Pteridaceae) – an addition to the fern flora of Uttar Pradesh, India
Shobhit Kumar Srivastava, S. Dominic Rajkumar and Shashank Kumar Singh 154

24. New distributional record of two species of *Ophioglossum* L. for the Deccan peninsula, India
Sachin Patil, Rajendra Lavate and Meena Dongare 156

Cover Photograph: Striped Hyena *Hyaena hyaena* By Meet Agrawal

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Editorial

Immediate Needs, Distant Concerns

The basic struggle between conservation and development can be encapsulated into immediate needs of human beings, and future or distant concerns such as depletion of natural resources (water, land, soil productivity, timber, fish stock) and climate change. Only for a few of us, wildlife and biodiversity is an immediate and a future concern. For politicians and decision makers of all hues, wildlife does not even register in their mind, except for the ritual lip service during some function or seminar. The campaign *Save Wildlife* is a good photo-opportunity and pretence during Wildlife Week and Biodiversity Day.

Whichever issues we look at, we find the same dichotomy – we take care of our immediate human needs, but do not care for future concerns. Water is a good example. No one can dispute that without clean water, life is not possible. Water is the basic life support system of our world. The grandiose plans that we are making to expand cities and build smart cities, and expand/intensify agriculture to feed the world, are not possible without freshwater. Interestingly, only 3% of water is freshwater, the rest is saline. Even in this 3%, slightly more than 1% is in the form of permanent ice at the poles. What we are left with is less than 2% of the world's water for our drinking, agriculture, and industrial needs. Such a precious natural resource, without which we cannot live, should be taken care of properly. But wetland destruction continues in most parts of the world, sometimes at an increasing rate, because of wetland-unfriendly land-use planning (Junk *et al.* 2013). Water is one of the most abused resources of the world. Look at what we are doing with our water resources. We are polluting rivers, draining lakes and ponds, over-using ground- and fossil- water as if there is no tomorrow. Our immediate needs make us blind to the distant future when river water will become totally unpotable (even now we cannot drink directly from most of our rivers), underground water will be exhausted, and fashionable malls or bus stations will be standing on urban lakes.

Indian villages, towns and cities, and our agriculture system survived hundreds of years by managing water resources properly. In arid areas, rainwater harvesting was a part of life. But now the situation is different. Our daily water requirement is supplied through pipes (not for all Indians though) that come from a distant reservoir that was built at great ecological and social costs. The social cost was paid by a poor farmer or tribal whose land was taken over for the reservoir – whereas we pay our water bill to the municipality. As long as I get my 'clean' water supply from a tap, why should I bother about the nearby lake that is getting filled up with garbage or is being encroached upon? My immediate need is met, so why should I bother that the nearby reservoir that may be 500 years old was recharging ground water, supplying irrigation water, was a source of fish and a habitat of wildlife. Such destruction of urban lakes and ponds is going on all over India. Bengaluru is a classic example, where nearly 50% of the lakes that supplied drinking water and moderated the climate have been destroyed.

Wild fish stocks are another classical example. Out of the 32 to 35 major fisheries of the world, 30 have collapsed or are collapsing due to industrial-scale overfishing. Our immediate need to feed the world with cheap fish has made us blind to our future needs. The irony is that sustainable fisheries involving restrictions on certain types of fishing gear, implementation of complicated international laws by nations, and restrictions on catch-size will provide us with sufficient fish for the present and in the future to feed the growing human population. The catch word is 'sustainability' that we human beings miss all the time. We have to develop systems that result in harvesting of wild fish stocks within safe biological limits. At present, such international restrictions, if present, are rarely followed in the high seas.

A slightly dated report of the Ecological Society of America (Palmer *et al.* 2005) puts it in a nutshell: 1. Ecological science can and must play a greatly expanded role in ensuring a future in

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which natural systems, and the human populations they include, exist on a more sustainable planet; 2. Implementation of a bold, proactive action plan for ecological science will generate the necessary knowledge to conserve, restore, and design the world's ecological systems; and 3. Ecologists must act now to inform decisions with ecological knowledge, advance innovative and anticipatory ecological research directed at sustainability, and stimulate cultural changes that facilitate a forward-looking and international ecology.

Most world leaders, politicians and decision makers are concerned only with economic development, Gross Domestic Product (GDP) and growth, without giving thought to the fundamental pillars on which our economic development stands: water, land, soil, climate, biological, human, and earth resources. These pillars are interconnected and depend on each other, as we depend on *all* of them. Our future depends on whether we are able to recognize or not that human civilizations cannot survive unless we make a quick transition towards sustainability at a personal level, at the local level, at landscape level, and at the global level as a whole. The time has come for sustainability science to leave the arcane pages of scientific journals and become mainstream, as the present and future of humankind and this planet depends on sustainable use of natural resources.

Asad R. Rahmani

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Journal of the Bombay Natural History Society, 111(2), May-August 2014 73-80

MOLECULAR SEXING OF THE CRITICALLY ENDANGERED SLENDER-BILLED VULTURE *GYPS TENUIROSTRIS* AND ITS CONSERVATION IMPLICATIONS

Mandar Dilip Kulkarni[1,3,5], Rohan Shringarpure[1,3,6], Chandra Mohan S.[2,7], Mohini Saini[2,8], Tapan K. Palai[2,9], Praveen K. Gupta[4], Purvi Bhatt[3,10], Nikita Prakash[1,11], Ashok Bhagwat[1,12] and Vibhu Prakash[1,13,*]

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The Slender-billed Vulture is probably the most endangered of the three resident *Gyps* vulture species of the Indian subcontinent, with a population of less than 1,000 individuals in the wild. A Conservation Breeding Programme was initiated by the Bombay Natural History Society (BNHS) to save this species from possible extinction. Sex identification of individuals is important to maintain the right sex ratio to maximize breeding success in the Conservation Breeding Programme. The Slender-billed Vulture is not sexually dimorphic, hence the applicability of polymerase chain reaction based (molecular sexing) methods for sex identification was assessed, and the first ever successful application of *W*-specific PCR combined with *ZW*-common PCR for sex identification in Slender-billed Vulture (n=12) was established. The PCR method was validated by comparing results with sex identification based on the study of breeding biology of nesting pairs. The reported molecular sexing method could prove a useful tool in management of Conservation Breeding Programmes, and also in determining the sex of dead birds collected from the wild during ecological studies.

Keywords: Molecular sexing, sex identification, Slender-billed Vulture, *W*-specific PCR, *ZW*-common PCR

INTRODUCTION

Over 97% population of the three resident *Gyps* species, Oriental White-backed Vulture *Gyps bengalensis*, Long-billed Vulture *G. indicus*, and Slender-billed Vulture *G. tenuirostris*, has disappeared from the Indian subcontinent since the early 1990s (Prakash *et al.* 2007). Due to the rapid decline, all three species are listed as Critically Endangered (IUCN 2013). The Slender-billed Vulture is probably the worst affected in the genus, as less than 1,000 individuals are estimated to survive in the wild (Prakash *et al.* 2007). The veterinary use of non-steroidal anti-inflammatory drug (NSAID) diclofenac was found to be the major cause for decline in the vulture populations (Cuthbert *et al.* 2009; Das *et al.* 2011; Green *et al.* 2006, 2007; Naidoo *et al.* 2009, 2010; Oaks *et al.* 2004; Swan *et al.* 2006). Vultures get exposed to toxic levels of diclofenac when they feed on carcasses of livestock that die within two to three days of administration of diclofenac. Following the discovery of diclofenac as the major cause of decline in the three resident *Gyps* species, diclofenac was banned for veterinary use in India and neighbouring countries (Kumar 2006; Singh 2008). However, misuse of human formulations in veterinary treatment was evident from various field surveys that showed the prevalence of drug residues in cattle carcasses at concentrations sufficient to cause decline in the vulture populations (Cuthbert *et al.* 2011a, b; Saini *et al.* 2012).

A number of *in situ* and *ex situ* conservation initiatives were undertaken in India and neighbouring countries to save the three resident *Gyps* species from possible extinction – a Conservation Breeding Programme by the Bombay Natural History Society (BNHS) being a major initiative. The objective of the Conservation Breeding Programme was to capture a specified number of individuals (to gather a genetically viable population) from the wild, breed them in captivity, and release them back into the wild after the major cause of decline was addressed. Currently in India, three Vulture Conservation Breeding Centres house the Slender-billed Vulture and the total population in captivity comprises 66 individuals. In view of the low number of birds available for breeding, knowing the sex ratio in this monogamous species is extremely important to facilitate maximum pair formation and breeding. However, determining sex in the Slender-billed Vulture (like the other two resident *Gyps* species) is not possible on morphological characters, as the species is not sexually dimorphic.

For sex identification of monomorphic birds, various techniques are available, such as laparotomy (Risser 1971), laparoscopy (Richner 1989), flow cytometry (Nakamura *et al.* 1990), karyotyping (Hatzofe and Getreide 1990), and Raman spectroscopy (Harz *et al.* 2008). However, the advanced polymerase chain reaction (PCR) based methods (molecular sexing methods) are preferred over these methods because of ease, high sensitivity, and accuracy (Fridolfsson and Ellegren 1999; Ghorpade *et al.* 2012). PCR-based methods rely on the variation in length of intron in the chromodomain-helicase-DNA-binding protein gene (CHD) present on *Z* and *W* sex chromosomes of birds. The oldest and most widely used method was *P2/P8* Griffiths' molecular sexing method (Griffiths *et al.* 1998) that provided reliable results with most species where intronic length variation among the CHD genes present on *W* and *Z* chromosomes was considerable. However, in species where intronic length variation was negligible (Accipitridae), the method was less accurate (Chang *et al.* 2008a,b,c; Ghorpade *et al.* 2012; Ito *et al.* 2003). A number of modifications of the original method were tried out over the years, in order to circumvent this problem. These involved the use of ARMS-PCR (Ito *et al.* 2003), PCR-RFLP (Sacchi *et al.* 2004), *W*-specific PCR combined with *ZW*-common PCR (Chang *et al.* 2008b), melting curve analysis (Chang *et al.* 2008a), TaqMan probe based real time PCR (Chang *et al.* 2008c; Chou *et al.* 2010) and single strand conformation polymorphism (SSCP) (Ramos *et al.* 2009). Among these, the *W*-specific PCR combined with *ZW*-common PCR had been successfully used for sex identification in Oriental White-backed, Long-billed, and Himalayan Vulture *Gyps himalayensis* (Ghorpade *et al.* 2012). In addition, the method was reported to be a simple, one-step method for unambiguous identification of sex in the tested species. However, as the applicability of this method had not been tried out for sex identification in Slender-billed Vulture, we tested this method at the Vulture Conservation Breeding Centre, Pinjore, during 2013–2014.

MATERIAL AND METHODS

Sample Collection

Blood samples were collected from 12 Slender-billed Vultures of the Pinjore Centre during routine health checks in October 2013. The samples were collected in 4 ml EDTA vacutainers and stored at 4 °C until isolation of genomic DNA.

Characterization and *in silico* analysis of CHD-*W* and CHD-*Z* sequences

Genomic DNA was isolated from the blood samples of a known male (A63) and female (A60) using an in-house developed genomic DNA isolation method (Kulkarni *et al.* unpubl.). The quality of DNA was checked in 1% agarose gel electrophoresis. The purity assessment and quantification of DNA samples were carried out using the Nanodrop 1000 spectrophotometer and ND 1000 V3.7.1 software.

The partial CHD-*W* and CHD-*Z* sequences were amplified using the *P2/P8* primer pair (Griffiths *et al.* 1998). PCR was carried out in 25 µl reaction volume, consisting of 1X reaction buffer with 2 mM magnesium chloride, 0.2 mM of each dNTP, 100 ng genomic DNA, 0.4 µM of *P2* (Forward 5'-TCTGCATCGCTAAATCCTTT-3') and *P8* (Reverse 5'-CTCCCAAGGTGAGRAAYTG-3') primers and 1 U *Pfu* Ultra II fusion HS DNA polymerase. Negative control with no genomic DNA was also run with every PCR. Thermal cycling conditions were set as initial denaturation at 94 °C for 4 min, followed by five cycles of 94 °C for 30 s, 49 °C for 30 s, 72 °C for 30 s, followed by 49 cycles of 94 °C for 30 s, 48 °C for 20 s, 72 °C for 20 s, with a final extension at 72 °C for 5 min. The obtained PCR products were separated on 2% agarose gel and purified using QIA quick gel extraction kit. Cloning of the extracted PCR products was carried out using pJET1.2 blunt end PCR cloning kit into *Escherichia coli* (DH5α) competent cells. From overnight grown cultures of transformed *E. coli*, plasmids were isolated using plasmid isolation kit. The plasmids were screened for the insert by PCR, using 0.4 µM of each of *T7* promoter primer as forward and *P8* as reverse primer with thermal cycling conditions as mentioned above. The positive plasmids were further characterized using PCR with *P2* as forward primer and *W*-specific (5'- GGTTTTCACACATGGCACA-3') or *ZW*-common (5'-GATCAGCTTTAATGGAAGTGAAG-3') as reverse primer. The thermal cycling conditions were set as initial denaturation at 95 °C for 7 min, 35 cycles of 95 °C for 30 s, 57 °C for 30 s, and 72 °C for 30 s, followed by final extension at 72 °C for 8 min. The characterized plasmids were sequenced at Xcelris Labs Ltd., Anand, Gujarat. Finally, the partial nucleotide sequences from the CHD-*W* and CHD-*Z* alleles of Slender-billed Vulture were aligned with the available CHD-*W* and CHD-*Z* sequences of Oriental White-backed, Long-billed, Himalayan, and Cinereous Vulture *Aegypius monachus* using MegAlign Lasergene software. From CHD-*W* and CHD-*Z* sequences of Slender-billed Vulture, the primer binding regions and recognition sites for the respective restriction endonucleases for ARMS-PCR, PCR-RFLP, and *W*-specific PCR were mapped *in silico*.

Molecular sexing by using *W*-specific PCR combined with *ZW*-common PCR

Genomic DNA isolated from the blood samples of 12 Slender-billed Vultures was qualitatively and quantitatively assessed as described in the above section.

W-specific PCR combined with *ZW*-common PCR suggested for Crested Serpent-Eagle *Spilornis cheela hoya* (Chang *et al.* 2008b) was employed for sex identification of 12 Slender-billed Vultures. The method employed two PCR: Reaction 'A' was common for the CHD alleles present on *Z* and *W* chromosomes, *ZW*-common primer and *P2* primer were used as reverse and forward primers respectively; Reaction 'B' was specific for the CHD-*W* allele, *W*-specific primer and *P2* primer were used as reverse and forward primers respectively. PCR was carried out in 25 µl reaction volume, using 1X reaction buffer, 1.5 mM magnesium chloride, 0.2 mM of each dNTP, 0.4 µM of either *ZW*-common primer or *W*-specific primer as reverse primer and *P2* primer as forward primer, 0.5 U Taq DNA polymerase and nuclease free water. 50 ng of the isolated genomic DNA was used as template. Negative control with no genomic DNA was also run with every PCR. Thermal cycling conditions were set as described above. The amplified PCR products were resolved on 2% agarose gel along with 100 bp DNA ladder as reference and analysed for presence (indicating female) or absence (indicating male) of 263 bp *W*-specific product.

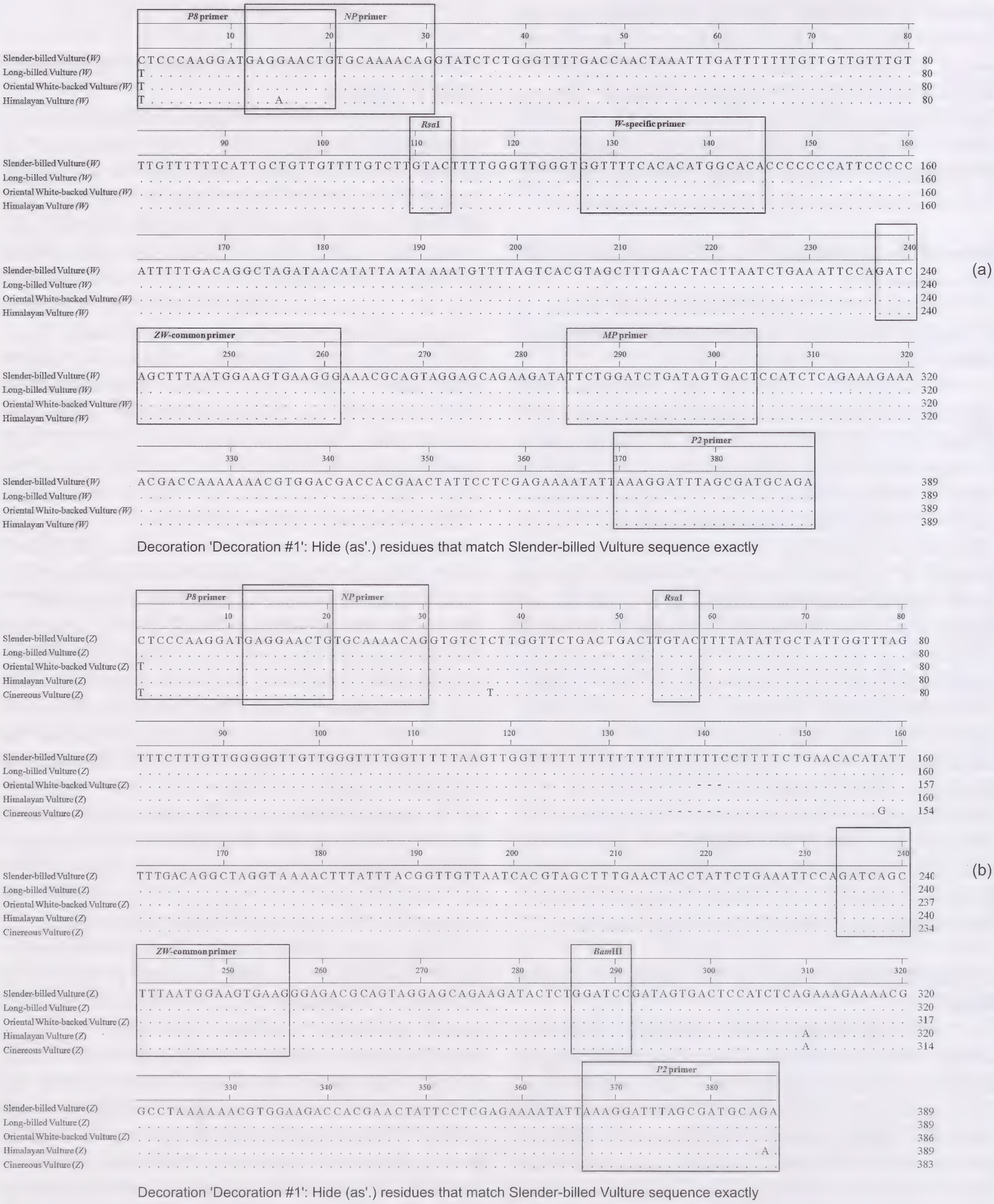
Sex identification based on the study of breeding biology

For sex identification based on the study of breeding biology, nest observations of three established pairs of tagged (numbered leg-bands) Slender-billed Vulture at the Pinjore Centre were carried out through CCTV monitors over three consecutive breeding seasons. Each of the three established breeding pairs, viz. A50-A56, A64-A58, and A55-A53, was observed once a week throughout the daylight hours. Data collection was carried out at various stages of breeding, i.e., nest building, coition/copulation, egg laying, hatching, and fledging. The coition and egg laying events provided clues to sex identification. The nests were observed intensively until hatching, and then less regularly till the nestlings fledged.

RESULTS

Characterization and *in silico* analysis of CHD-*W* and CHD-*Z* sequences

The CHD-*Z* and CHD-*W* sequences from Slender-billed Vulture, amplified using Griffiths' *P2/P8* primers and the PCR products, were successfully cloned, and the recombinant plasmid sequence characterized. Alignment report for CHD-*Z* sequence was prepared using the available data from other vulture species, namely Oriental White-backed, Long-billed, Himalayan, and Cinereous Vultures by Clustal W (Ghorpade *et al.* 2012). Similarly, alignment report for CHD-*W* sequence was prepared using the available data from Oriental White-backed, Long-billed, and Himalayan Vultures by Clustal W (Ghorpade *et al.* 2012; Fig. 1). Result of percent identity demonstrated that the characterized CHD-*Z* sequence for Slender-billed Vulture was identical to that of the Long-billed Vulture, and 98.9%, 99.5%, 99.7% similar to that of the Cinereous, Himalayan, and Oriental White-backed Vulture respectively. The percent identity of Slender-billed Vulture CHD-*W* sequence with that of Himalayan Vulture was 99.5%, and 99.7% with Oriental White-backed and Long-billed Vulture. The primer binding regions for primers *P2*, *P8*, *NP*, *MP*, *ZW*-common, and *W*-specific were located and marked along with the recognition sequences for restriction endonucleases *Bam*HI and *Rsa*I on the alignment reports (Fig. 1). The primer binding regions for *MP* and *W*-specific primers were recorded only on the CHD-*W* sequence. The recognition sequence for restriction enzyme *Rsa*I was found at different locations on CHD-*W* and CHD-*Z* sequences, but the *Bam*HI specific recognition sequence was recorded only on CHD-*Z* sequence. Based on identified recognition sequences and primer binding regions, the applicability of various PCR-based methods was predicted (Table 1). It was evident from the predicted gel pattern that in Griffiths' *P2/P8* method, the amplified CHD-*Z* and CHD-*W* sequences would have negligible intronic length (3 bp) variation. In PCR-RFLP, the digestion of the *P2/P8* PCR amplicon with *Bam*HI would yield two bands of 286 bp and 100 bp for CHD-*Z* sequence, and CHD-*W* would not be digested. Thus, females would produce three bands of 389 bp, 286 bp, and 100 bp, and males would produce two bands of 286 bp and 100 bp. Likewise, the *Rsa*I digestion of *P2/P8* amplicon would generate two fragments of 278 bp and 111 bp for CHD-*W* sequence, and two fragments of 330 bp and 56 bp for CHD-*Z* sequence, i.e. two fragments of 330 bp and 56 bp in males and four fragments of 330 bp, 278 bp, 111 bp and 56 bp in females. In ARMS-PCR using *P2/NP/MP* primers, a multiplex-PCR would produce two bands of 378 bp and 293 bp for CHD-*W* sequence and one band of 375 bp for



```
Slender-billed Vulture (W)        CTCCCAAGGATGAGGAACTGTGCAAAACAGGTATCTCTGGGTTTTGACCAACTAAATTTGATTTTTTTGTTGTTGTTTGT 80
Long-billed Vulture (W)           T............................................................................... 80
Oriental White-backed Vulture (W) T............................................................................... 80
Himalayan Vulture (W)             T.............A................................................................. 80

Slender-billed Vulture (W)        TTGTTTTTTCATTGCTGTTGTTTTGTCTTGTACTTTTGGGTTGGGTGGTTTTCACACATGGCACACCCCCCCATTCCCCC 160
Long-billed Vulture (W)           ................................................................................ 160
Oriental White-backed Vulture (W) ................................................................................ 160
Himalayan Vulture (W)             ................................................................................ 160

Slender-billed Vulture (W)        ATTTTTGACAGGCTAGATAACATATTAATAAAATGTTTTAGTCACGTAGCTTTGAACTACTTAATCTGAAATTCCAGATC 240
Long-billed Vulture (W)           ................................................................................ 240
Oriental White-backed Vulture (W) ................................................................................ 240
Himalayan Vulture (W)             ................................................................................ 240

Slender-billed Vulture (W)        AGCTTTAATGGAAGTGAAGGGAAACGCAGTAGGAGCAGAAGATATTCTGGATCTGATAGTGACTCCATCTCAGAAAGAAA 320
Long-billed Vulture (W)           ................................................................................ 320
Oriental White-backed Vulture (W) ................................................................................ 320
Himalayan Vulture (W)             ................................................................................ 320

Slender-billed Vulture (W)        ACGACCAAAAAAACGTGGACGACCACGAACTATTCCTCGAGAAAATATTAAAGGATTTAGCGATGCAGA 389
Long-billed Vulture (W)           ..................................................................... 389
Oriental White-backed Vulture (W) ..................................................................... 389
Himalayan Vulture (W)             ..................................................................... 389
```

Decoration 'Decoration #1': Hide (as'.) residues that match Slender-billed Vulture sequence exactly

```
Slender-billed Vulture (Z)        CTCCCAAGGATGAGGAACTGTGCAAAACAGGTGTCTCTTGGTTCTGACTGACTTGTACTTTTATATTGCTATTGGTTTAG 80
Long-billed Vulture (Z)           ................................................................................ 80
Oriental White-backed Vulture (Z) T............................................................................... 80
Himalayan Vulture (Z)             ................................................................................ 80
Cinereous Vulture (Z)             T...................................T........................................... 80

Slender-billed Vulture (Z)        TTTCTTTGTTGGGGGTTGTTGGGTTTTGGTTTTTAAGTTGGTTTTTTTTTTTTTTTTTTTTTCCTTTTCTGAACACATATT 160
Long-billed Vulture (Z)           ................................................................................ 160
Oriental White-backed Vulture (Z) ..........................................................---................... 157
Himalayan Vulture (Z)             ................................................................................ 160
Cinereous Vulture (Z)             .......................................................------................G.. 154

Slender-billed Vulture (Z)        TTTGACAGGCTAGGTAAAACTTTATTTACGGTTGTTAATCACGTAGCTTTGAACTACCTATTCTGAAATTCCAGATCAGC 240
Long-billed Vulture (Z)           ................................................................................ 240
Oriental White-backed Vulture (Z) ................................................................................ 237
Himalayan Vulture (Z)             ................................................................................ 240
Cinereous Vulture (Z)             ................................................................................ 234

Slender-billed Vulture (Z)        TTTAATGGAAGTGAAGGGAGACGCAGTAGGAGCAGAAGATACTCTGGATCCGATAGTGACTCCATCTCAGAAAGAAAACG 320
Long-billed Vulture (Z)           ................................................................................ 320
Oriental White-backed Vulture (Z) ................................................................................ 317
Himalayan Vulture (Z)             .....................................................................A.......... 320
Cinereous Vulture (Z)             .....................................................................A.......... 314

Slender-billed Vulture (Z)        GCCTAAAAAACGTGGAAGACCACGAACTATTCCTCGAGAAAATATTAAAGGATTTAGCGATGCAGA 389
Long-billed Vulture (Z)           .................................................................. 389
Oriental White-backed Vulture (Z) .................................................................. 386
Himalayan Vulture (Z)             ................................................................A. 389
Cinereous Vulture (Z)             .................................................................. 383
```

Decoration 'Decoration #1': Hide (as'.) residues that match Slender-billed Vulture sequence exactly

Fig. 1: Sequence alignment of CHD-*Z* and CHD-*W* sequences amplified by Griffith's universal primer P2/P8 from Slender-billed Vulture with Oriental White-backed, Long-billed, Himalayan and Cinereous Vulture by Clustal W (MegAlign DNAstar). (a) alignment of CHD-W sequences (b) alignment of CHD-*Z* sequences

Note: Sequences of primers *P2, P8, NP, MP*, *ZW*-common, *W*-specific and recognition sites of *Rsa*I, *Bam*HI are boxed and dotted (...) lines indicate sequence similarity

Table 1: Predicted gel pattern for analysing applicability of available molecular sexing methods for Slender-billed Vulture

P2/P8		PCR-RFLP				ARMS PCR (Multiplex with P2/NP/MP primers)		W-specific PCR			
		*Bam*HI digest of P2/P8 amplicon		*Rsa*I digest of P2/P8 amplicon				P2/ZW-common		P2/W-specific	
Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
389(W)	Nil	389		330		378(P2/NP-W)		153(W)		263(W)	Nil
386(Z)	386(Z)	286	286	278	330	375(P2/NP-Z)	375(P2/NP-Z)	153(Z)	153(Z)		
		100	100	111		293(MP/NP-W)					
				56	56						

Note: PCR amplicon size is in 'bp'

CHD-*Z* sequence, i.e. two bands for females, one common band for 378 bp and 375 bp and the other for 293 bp, and one band of 375 bp for males. Another method employing *W*-specific PCR combined with *ZW*-common PCR would produce one amplicon each for both the sexes of 153 bp for CHD-*Z* and CHD-*W* sequences using *P2*/*ZW*-common primer (Reaction 'A') and one amplicon of 263 bp, only for the CHD-*W* sequence using *P2*/*W*-specific primer (Reaction 'B'). Thus, in two separate PCRs, males would show a single amplicon for *P2*/*ZW*-common, while females would show single amplicon each for both *P2*/*ZW*-common and *W*-specific.

Molecular sexing using *W*-specific PCR combined with *ZW*-common PCR

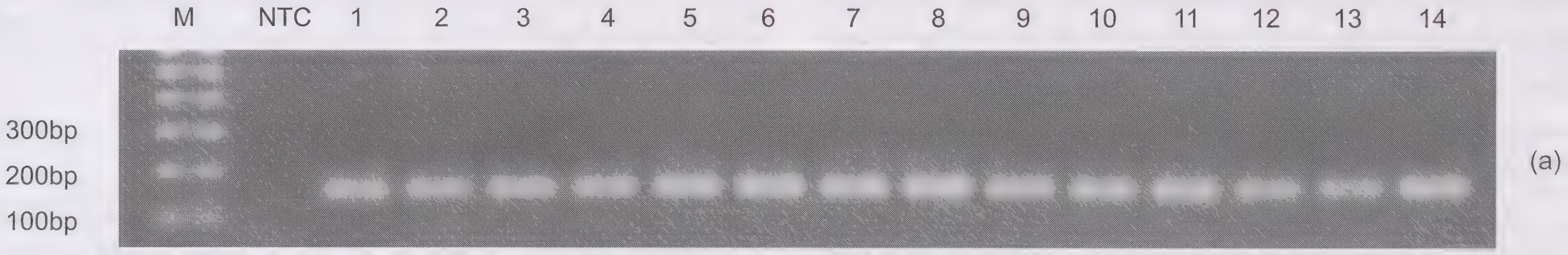
The *W*-specific PCR combined with *ZW*-common PCR was successfully used for sex identification of all the 12 Slender-billed Vultures. Six were identified as males (A50, A64, KA, UA, UT, A55) and six as females (A52, A56, A57, A58, CV, A53) (Fig. 2). As predicted (Fig. 1), the results showed presence of PCR product in reaction 'A' for both the sexes, as a band of 153 bp on 2% agarose gel. PCR product in reaction 'B' was recorded for only female as a band of 263 bp on 2% agarose gel. No PCR product for males was recorded in reaction 'B' (Fig. 2) as the *W*-specific primer does not have any binding site on CHD-*Z* allele.

Sex identification based on the study of breeding biology

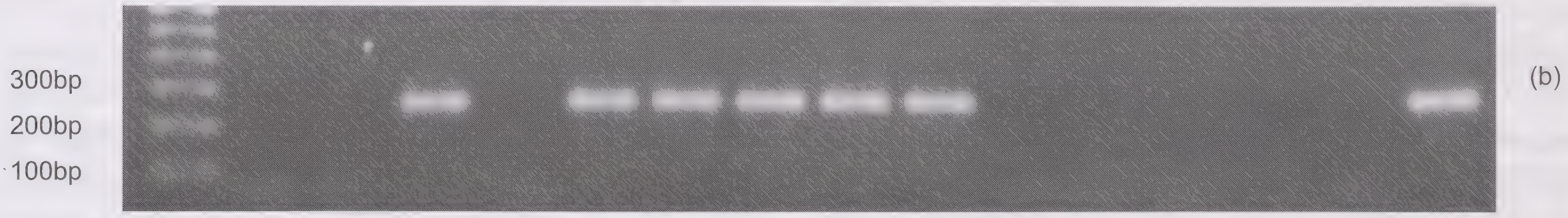
All the individuals of the three established breeding pairs did not show any external sexual morphological differences. Based on the study of breeding biology of the three breeding pairs, A50, A64, and A55 were identified as males, and A56, A58, and A53 were identified as females, which was in concurrence with the results of molecular sexing.

DISCUSSION

W-specific PCR combined with *ZW*-common PCR was found to be a simple and reliable method for sex identification of the critically endangered Slender-billed



(a) PCR products from *P2/ZW*-common PCR



(b) PCR products from *P2/W*-specific

Fig. 2: Gel electrophoresis of PCR amplicons obtained for sex identification of Slender-billed Vulture using the W-specific PCR combined with ZW-common PCR in 2% agarose gel PCR. M: 100 bp DNA ladder, NTC: No template control, Lanes 1-14 individual samples listed as 1: Male positive control, 2: Female positive control, 3: A50 (vulture tag number), 4: A52, 5: A56, 6: A57, 7: A58, 8: CV, 9: A64, 10: KA, 11: UA, 12: UT, 13: A55, 14: A53

Vulture, after screening the available PCR methods. The screening consisted of the following steps: characterization of CHD-*Z* and CHD-*W* sequences; *in silico* analysis of characterized sequences for predicting the applicability of available molecular sexing methods; application of *W*-specific PCR combined with *ZW*-common PCR for sex identification; and finally, validation. The CHD-*W* and CHD-*Z* sequences for the species were successfully cloned, characterized, and submitted to the NCBI GenBank. The submitted CHD-*W* and CHD-*Z* sequences of Slender-billed Vulture were assigned NCBI accession numbers KF977832 and KF977833 respectively.

For reliable sex identification, discriminating the CHD-*Z* and CHD-*W* amplicons was very important and any deviation would have resulted in false identification of sexes. Hence, the obtained sequences were analysed *in silico* for predicting applicability of available PCR-based methods for sex identification. The similarity among the sequences of various species proved significant during *in silico* analysis. The *in silico* analysis predicted that molecular methods previously used for identification of sex in Oriental White-backed and Long-billed Vulture (Ghorpade *et al.* 2012) would also be applicable in sex identification of Slender-billed Vulture. Similarity in the sequences among vulture species also meant that similar inherent problems can arise during sex identification of this species, and hence, predicting a simple and robust method was essential for unambiguous sex identification and application at Conservation Breeding Centres with basic laboratory facilities.

The small intronic length variation (only 3 bp) between amplicons, obtained using the Griffiths' *P2* and *P8* primers for the CHD-*Z* and CHD-*W* alleles, would make sex identification impossible as PCR products corresponding to CHD-*Z* and CHD-*W* alleles for female individuals cannot be differentiated on agarose gels. Similar problems have been reported in other species, and in particular among raptors in earlier studies (Chang *et al.* 2008a, b, c; Ghorpade *et al.* 2012; Ito *et al.* 2003).

The PCR-RFLP using Griffiths' *P2/P8* PCR followed by *Bam*HI or *Rsa*I restriction digestion could be a potential method for sex identification as shown in the case of other *Gyps* species (Ghorpade *et al.* 2012) and Short-toed Snake-Eagle *Circaetus gallicus* (Sacchi *et al.* 2004); however, the method requires an additional step of restriction digestion after PCR. Usage and difficulty in prolonged storage of restriction enzymes at field-based laboratories further restrict the application. Likewise, another predicted approach, ARMS-PCR using the *MP*, *NP* and Griffiths' *P2* primer used for sex identification in a number of Falconiformes species (Ito *et al.* 2003), and indicated earlier for sex identification of Oriental White-backed and Long-billed Vulture with some reservations (Reddy *et al.* 2007), would be unsuitable for the Slender-billed Vulture. The presence of only one nucleotide mismatch in primer *MP* for the CHD-*Z* and CHD-*W* alleles could lead to some ambiguity in interpretation with this method as described earlier (Ghorpade *et al.* 2012). The multiple alignments at all the repititions also predicted possible application of *W*-specific PCR combined with *ZW*-common PCR for sex identification. This method employing *ZW*-common and *W*-specific primers with Griffiths' *P2* primer had been derived from the method reported for sex identification for Crested Serpent-Eagle (Chang *et al.* 2008b), and was successfully applied for sex identification of Oriental White-backed and Long-billed Vultures earlier (Ghorpade *et al.* 2012). The method is also simple and does not require the use of any restriction enzyme or additional step.

The results of the *W*-specific PCR combined with *ZW*-common PCR method for sex determination matched the results of the study carried out on the breeding biology of three breeding pairs. Although observations on breeding pairs could assist in determining sex in monomorphic species, this requires observing the established breeding pairs (with tagged individuals) for at least two or three breeding seasons. In addition, sex identification of non-breeding individuals would be impossible, unlike molecular sexing, which provides quick and unambiguous results for any age group. Sex identification at our Conservation Breeding Centres is important as most of the wild-caught individuals (*c.* 70%) were nestlings, juveniles, or subadults, and managing sex ratio in captive populations before breeding commences is important to achieve high breeding success. Molecular sexing could also be used for sex identification of Slender-billed Vultures found dead in the wild, as the gonads in birds are reported to regress completely during the non-breeding season (Hau 2001; Nazrul Islam *et al.* 2012; Sharah *et al.* 2007).

Conservation Implications

The findings of the study revealed that *W*-specific PCR combined with *ZW*-common PCR is a simple and reliable method for sex identification of Slender-billed Vulture. This molecular sexing method needs to be adopted for all Slender-billed Vultures in captivity to aid in management of sex ratio to improve breeding success. The method could also be important in field studies of the species for sex identification of dead birds found in the wild. The method had been applied for sex identification in Crested Serpent-Eagle, Oriental White-backed, Long-billed, and Himalayan Vultures in the past. *W*-specific PCR combined with *ZW*-common PCR may also find applications in sex identification of monomorphic, rare, and endangered raptor species of Accipitridae recorded across the globe.

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THE GRASSLAND BIRDS OF ROLLAPADU WILDLIFE SANCTUARY, ANDHRA PRADESH, INDIA, WITH SPECIAL REFERENCE TO THE IMPACT OF GRAZING-FREE ENCLOSURES

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Grassland bird composition was studied in grazed (village grazing lands) and ungrazed grasslands (grassland enclosures of the Forest Department) at Rollapadu Wildlife Sanctuary from August 1992 to July 1994, using belt transect sampling. A total of 32 grassland dependent birds (21 resident, 4 winter migrant, and 7 seasonal migrant) were recorded in both the habitat types. Of these, 25 species were recorded in each of the two habitat types with 20 of them common to both. Although based on small sample size, our study showed that the species composition differed between grazed and ungrazed grasslands. Five species common in grazed grassland (Indian Courser *Cursorius coromandelicus*, Red-wattled Lapwing *Vanellus indicus*, Red-winged Bush-Lark *Mirafra erythroptera*, Rufous-tailed Finch-Lark *Ammomanes phoenicurus*, and Plain Prinia *Prinia inornata*) were not recorded in ungrazed grassland, while two species common in ungrazed grassland (Zitting Cisticola *Cisticola juncidis* and Black Drongo *Edolius macrocercus*) were not recorded in grazed grassland. The abundance of certain bird species differed between the grazed and ungrazed grassland. Ungrazed grassland had higher numbers of Oriental Skylark *Alauda gulgula*, while the numbers of Sykes's Crested Lark *Galerida deva*, Ashy-crowned Sparrow-Lark *Eremopterix grisea*, and Yellow-wattled Lapwing *Vanellus malabaricus* were greater in grazed grassland. These differences could be due to the impact of livestock grazing, protection, the interaction of relative abundance of food resources and foraging strategy of birds, and/or other unknown factors. The study suggests that mosaics of grazed and ungrazed grasslands may result in an increase in grassland bird diversity. However, since the majority of Indian grasslands are grazed, we recommend the establishment of more grazing-free refuges encompassing different grassland types, to conserve bird species intolerant to grazing. There necessarily has also to be a landscape-level conservation strategy since the majority of India's grasslands have high human dependence, and thus, their conservation requires the support of local communities in the long run.

Keywords: grassland birds, Rollapadu Wildlife Sanctuary, Great Indian Bustard, *Ardeotis nigriceps*, Lesser Florican, *Sypheotides indicus*, grazing

INTRODUCTION

Grasslands are neglected ecosystems in India, tend to be either overgrazed or considered as wastelands in need of afforestation, and have been largely overlooked in most governmental and conservation plans (Rahmani 1988, 1997). However, their values, especially as ecosystems supporting wildlife, started to be recognized in the mid 1980s (Anon. 1990; Maheswaran 2002; Narayan 1992; Rahmani 1989, 1997, 2006, 2008; Sankaran 1991; Zarri *et al*. 2005). One of the recommendations during and after an intensive study undertaken on the now Critically Endangered Great Indian Bustard *Ardeotis nigriceps* (Rahmani 1989; Rahmani and Manakadan 1988, 1990), hereafter GIB, was the establishment of grazing-free grassland enclosures for its conservation. Adopting this recommendation, the Andhra Pradesh Forest Department established grazing-free enclosures for the GIB at Rollapadu after its occurrence was reported there in 1982.

The establishment of enclosures in Rollapadu was found to benefit many other grassland fauna such as Blackbuck *Antilope cervicapra*, Indian Fox *Vulpes bengalensis*, Wolf *Canis lupus*, Black-naped Hare *Lepus nigricollis nigricollis*, and Common Indian Monitor *Varanus bengalensis* (Manakadan and Rahmani 1993). However, their impact on most other grassland bird species was largely unknown. Hence, as part of a project on grasslands of the Indian plains, we conducted a study on the grassland birds of Rollapadu during 1992–1995, with special reference to the impact of grazing-free enclosures (Manakadan and Rahmani 1997). The findings of this study are significant in the context of conservation of grassland birds in countries like India, and additionally, pertain to a case of biodiversity conservation of grasslands in a human-impacted landscape.

STUDY AREA

Location and Climate

Rollapadu Wildlife Sanctuary (6.14 sq. km, hereafter RWS) lies 18 km southeast of Nandikotkur (15° 58' N; 78° 18' E), Kurnool district, Andhra Pradesh, in the plains between the Nallamalai and Yerramalai hills, and at an altitude of

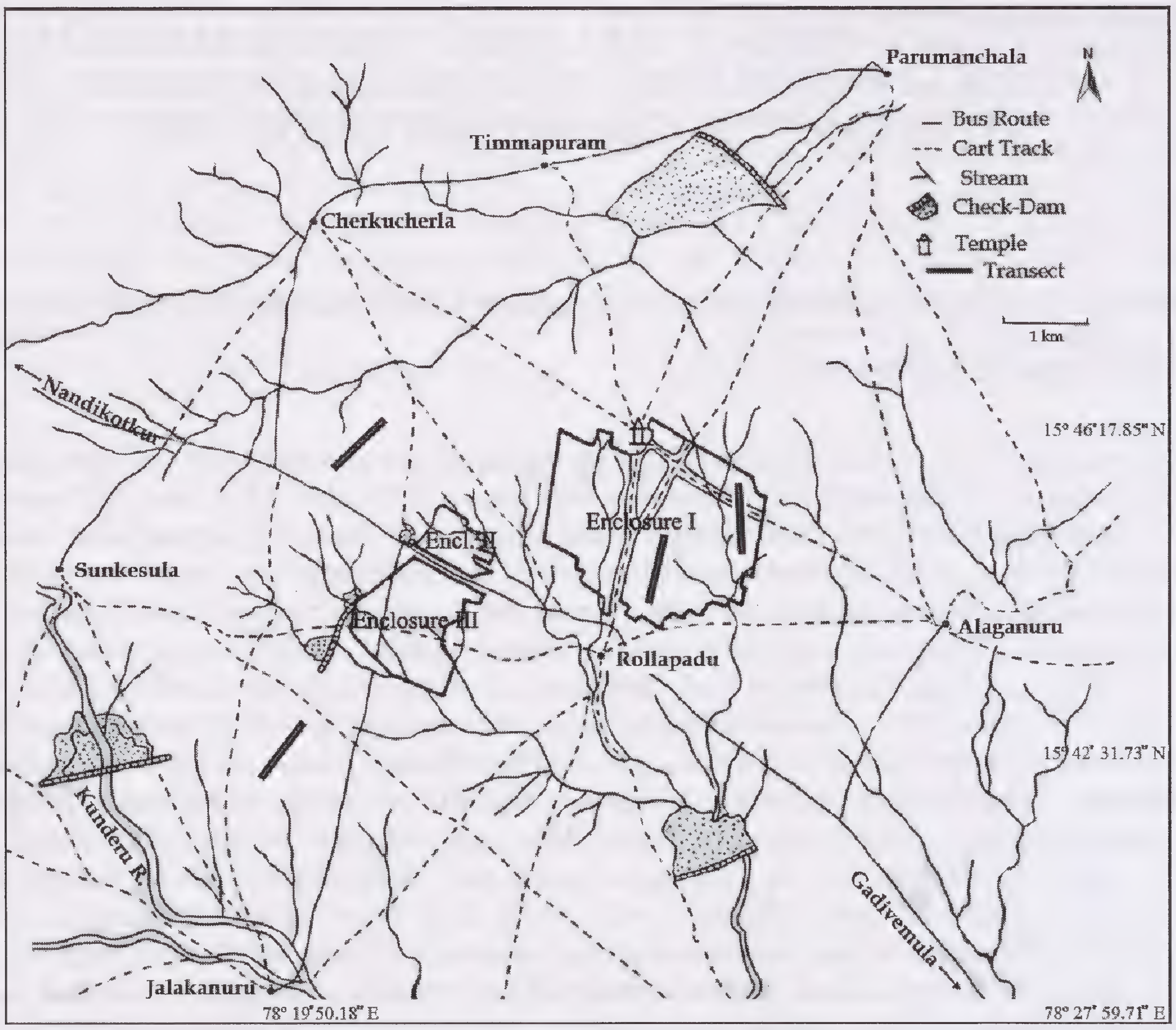

Fig. 1: Rollapadu Wildlife Sanctuary and surrounding areas

c. 200 m above msl. The terrain is gently undulating with streams flowing in the depressions during the monsoon. RWS primarily consists of three grassland plots (Fig. 1): Enclosure I (320 ha), Enclosure II (40 ha), and Enclosure III (120 ha). The enclosures are demarcated by trench-cum-mound (TCM) walls, which primarily serve as a demarcation boundary to deter humans and their livestock, and do not hinder the movement of wildlife. The region is semi-arid with an average annual rainfall of 668 mm, received from both the southwest monsoon (June to August) and northeast monsoon (September to December). Summer (March to May) temperature peaks at 42 °C, and winter (November to February) is mild (17 °C).

Vegetation

The area is a mosaic of short, open grasslands with scattered small shrubs and trees like *Prosopis cineraria*, *Cassia fistula*, *Butea monosperma*, *Ziziphus mauritiana*, *Morinda tinctoria*, *Carissa spinarum*, and *Cassia auriculata.* Scrub vegetation occurs along the lower reaches of streams, but faces severe woodcutting pressure. Common tree/scrub species along streams are *Canthium parviflora*, *Diospyros melanoxylon*, *Dolichandrone falcata*, *Mitragyna parvifolia*, *Morinda tinctoria*, *Maytenus emarginata*, and *Phoenix sylvestris*. The grasslands of Rollapadu, which owe their origin to deforestation, fire, and grazing (Dabadghao and Shankarnarayan 1973), come under the *Sehima-Dichanthium* type – *Dichanthium* occurring in alluvial soil areas (now mostly under cultivation) and *Sehima* in non-alluvial soils.

Grazed Grassland: The grass is short (*c*. 15 cm), patchy with much exposed bare ground. A total of 23 species were recorded. Species diversity (2.25) and evenness (0.72) values were high due to lack of dominance by a few species, unlike in ungrazed grassland. The grass community was of *Chrysopogon fulvus-Heteropogon contortus-Melanocenchris jacquemontii* type (Manakadan and Rahmani 1997).

Ungrazed Grassland: The grass growth was dense (except in areas of exposed rock or alkaline soil), averaging 50 cm in height. A total of 17 species were recorded. Species diversity (0.58) and evenness (0.21) were low due to dominance by a few species. The grass community was of *Heteropogon contortus-Chrysopogon fulvus-Eremopogon foveolatus* type. *Sehima nervosum* (the climax species of the soil type) had regenerated in some areas forming pure stands. In wet season, the month-wise mean (dry) biomass production was about 125% higher than grazed grassland. In summer, the standing (dead) grass biomass was fourfold higher than in grazed grassland (Manakadan and Rahmani 1997).

Livestock and Agriculture

Livestock consists of cows, buffaloes, sheep, and some goats, with a density of 138 animals/sq. km. Grazing begins with the onset of southwest monsoon in June and ends by December with drying-up of grasslands. After this, sheep, which are totally dependent on grasslands, migrate to other areas, and cows and buffaloes are largely stall-fed. Dry-land agricultural crops such as jowar *Sorghum bicolor*, groundnut *Arachis hypogaea*, cotton *Gossypium arboreum*, redgram *Cajanus cajan*, foxtail millet *Setaria italica*, and sesame *Sesamum indicum* are grown. The cropping season starts in June and ends by February, except in a few places where irrigation is available, where vegetables such as tomato, brinjal (egg plant), chillies, and beans are cultivated.

Fauna

Besides the GIB, the other major fauna are Blackbuck *Antilope cervicapra* (*c*. 450 animals – Manakadan and Rahmani 1993, 1998), the Wolf *Canis lupus*, Golden Jackal *Canis aureus*, Jungle Cat *Felis chaus*, Indian Grey Mongoose *Herpestes edwardsi*, Indian Hare *Lepus (Indolagus) nigricollis nigricollis*, Common Indian Monitor *Varanus bengalensis*, and Lesser Florican *Sypheotides indicus*. The sanctuary is a major roosting ground of harriers, largely Montagu's Harrier *Circus pygargus* (Rahmani and Manakadan 1986).

METHODS

Two one-kilometre transects were laid in grazed and ungrazed grasslands (enclosures of Forest Department), and these were sampled in the morning every fortnight from August 1992 to July 1994 (Fig. 1). Each transect was walked 31 times, covering all the seasons of the two years. Both transects in ungrazed grassland were laid only in Enclosure I (320 ha), since Enclosure II was too small (40 ha), and the ban on grazing in Enclosure III (120 ha) was not enforced due to protests of loss of grazing lands. Areas around streams were skipped as these are scrub dominated, supporting scrubland birds (Manakadan *et al.* 2002).

It was not possible to have more transects due to scarcity of ungrazed grassland habitat. The transects in grazed grassland were laid as far away from crop fields as possible, and at least 1.5 km away from enclosures, to reduce the impacts of edge effects. In case of transects within the enclosure, one was sufficiently far from crop fields while the other bordered crop fields. Although this site could be potentially impacted by birds that frequented crop fields, it was observed that these birds, such as parakeet, babblers, chats, robins, warblers, starlings, and crows, did not generally 'stray' into grasslands or were transient.

For estimating species densities, distance bands were selected based on the bird's body size. For small species (e.g., larks, pipits, cisticolas, quails, and munias), the width was 50 m (on either side of transect), as these birds could be easily missed or were difficult to identify if a larger width was adopted. For larger birds (e.g., drongos, doves, harriers, lapwings), the width was 150 m, and it was 300 m for the GIB. The proportion of individuals missed within these distance bands would not be much since sampling was carried out in the mornings when birds are most active, and the overall grass height differed only by *c*. 30 cm. Because of this, we are confident that the results fairly reflect the profile of the bird communities in the two habitat types, which was also suggested during our other regular field trips to the study area during the three study years.

Data Analysis

Only terrestrial, arboreal, or aerial species that were predominantly grassland dependent, and were not transient, were considered for analysis. Two pipit species – Tawny Pipit *Anthus campestris* (a winter migrant to the Indian region: Ali and Ripley 1987), and the Paddyfield Pipit *Anthus rufulus* (a resident species in the Indian region: Ali and Ripley 1987) were extremely difficult to tell apart in field, and were pooled during analysis (Table 1). Due to the small number of spatial replicates (2 transects/habitat type), only exploratory analysis of the data was carried out, wherein mean and standard deviations of bird densities were estimated from 30 temporal replications of each transect. The densities given in the tables are either annual or seasonal, based on the status of the species. Densities were calculated by dividing the number of birds recorded in a transect by its area, which was 0.1 sq. km for small birds, 0.3 sq. km for larger birds and 0.6 sq. km for the GIB.

RESULTS AND DISCUSSION

Grassland Birds of Rollapadu Wildlife Sanctuary

A total of 32 species of grassland birds were recorded from grazed and ungrazed grasslands (Table 1). Of these, 19 species are obligate inhabitants of grasslands in India, while 13 use grasslands as part of a wider array of habitats (Ali and Ripley 1987). The former included largely typical grassland birds such as quails, larks, pipits, harriers, lapwings, and bustards, and the latter were species such as doves, shrikes, drongos, swallows, and munias. Of the 32 species, 21 are residents, 4 are seasonal migrants, and 7 are winter migrants (Table 1). The Rain Quail *Coturnix coromandelica*, Common Quail *Coturnix coturnix*, Black Drongo *Edolius macrocercus*, and Lesser Florican *Sypheotides indicus* were treated as seasonal migrants to RWS. The Rain Quail is

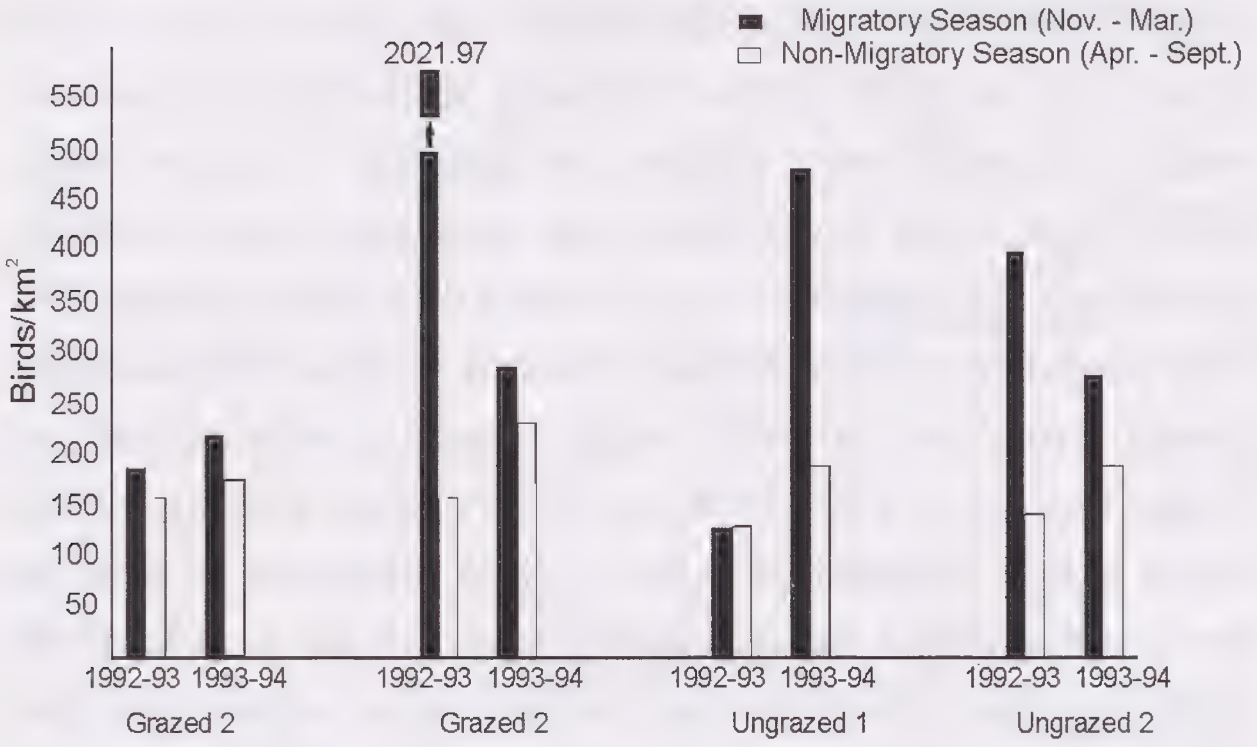

Fig. 2: Overall densities of grassland bird species in ungrazed and grazed grasslands of Rollapadu Wildlife Sanctuary

Note: The extremely high value for Grazed 2 during 1992–93 was due to a record of a huge flock of Greater Short-toed Lark *Calandrella brachydactyla* in November 1993

generally detected based on calls, but since it shies away from human observers, detections on transects are rare. There were only a few records of Common Quail. Since records of these two species were obtained mainly from September to February, they are treated as seasonal migrants. The only other quail in the area is the Jungle Bushquail *Perdicula asiatica*, which is largely found in scrub dominated areas, and is seen throughout the year, unlike the Rain and Common Quails, which further suggests that they are seasonal migrants. The Black Drongo, though seen frequently in the countryside, frequents the Rollapadu grasslands only from September to February, and hence is treated as a seasonal migrant. The endangered Lesser Florican was observed every year during this study, appearing in October and leaving by June, after males attained breeding plumage (Manakadan and Rahmani 1999). However, during an earlier study (Sankaran and Manakadan 1990), Lesser Florican was not recorded during the first two years, and was sighted during the third year (1987), with three territorial cocks displaying in partial breeding plumage from October and a nest located in November. This was a drought year in Rajasthan, Gujarat, and western Madhya Pradesh, which are their major breeding grounds (Ali and Ripley 1987).

Grassland birds in grazed and ungrazed grassland

The study showed no difference in bird species richness and overall abundance in grazed and ungrazed grassland, unlike reported from other studies (Bock and Bock 1988; Rohrbaugh *et al.* 1999; Temple *et al.* 1999). In the two grassland types sampled, 25 species each were recorded, 19 of which were common to both habitat types (Table 1). The overall densities of birds between the two habitat types also did not show much variation, with both sites recording higher numbers during winter due to the influx of migrants (Fig. 2). However, there were differences in the abundance of some species to the point of total/near absence in either of the habitat types. Five species (Indian Courser *Cursorius coromandelicus*, Red-wattled Lapwing *Vanellus indicus*, Red-winged Bushlark *Mirafra erythroptera*, Rufous-tailed Finch-Lark *Ammomanes phoenicurus*, and Plain Prinia *Prinia inornata*) that were common in grazed grassland were not recorded in ungrazed grassland, while two species common in ungrazed grassland (Zitting Cisticola *Cisticola juncidis* and Black Drongo *Edolius macrocercus*) were not recorded in grazed grassland (Table 1). The ungrazed grassland recorded higher numbers of Oriental Skylark *Alauda gulgula*, while the abundance of Sykes's Crested Lark *Galerida deva*, Ashy-crowned Sparrow-Lark *Eremopterix grisea*, and Yellow-wattled Lapwing *Vanellus malabaricus*, were more in grazed grassland (Table 1).

Impacts of grazing-free enclosures

The establishment of enclosures has primarily resulted in an increase in cover of grassland vegetation, making it unsuitable for species that prefer open conditions. This has caused disappearance or decline of bird species dependant on grazing, and increase of bird species intolerant to grazing pressure, as has been reported in a number of studies (Bock *et al.* 1993; Koford 1999; Nuttall 1993). For example, a few sightings of Ashy-crowned Sparrow-Lark (a common species in grazed grasslands) in enclosures were in rocky areas with sparse grass growth. For some species, preference of grass height differs between activities. For example, the GIB has an overall preference for short to medium grass (up to 50 cm) for foraging, roosting, and nesting, but prefers tall grass (*c.* 75 cm) for resting and chick-rearing (Manakadan 1986; Rahmani 1989; Rahmani and Manakadan 1988).

Grasshoppers are an important prey for insectivorous birds in grasslands (McEwen 1987; Wiens and Rotenberry 1979). Sampling of grasshopper in RWS showed that the species richness and overall abundance of grasshoppers (identified up to genus level) did not vary between the two habitat types, but there were differences in the abundance of five of the seven commonly recorded grasshoppers. *Acorypha* sp., *Pyrrhicia* sp., and *Trilophidia* sp. were more abundant in ungrazed grassland, while *Chrotogonus* sp. and *Dnopherula* sp. were abundant in grazed grassland (see Manakadan and Rahmani 1997). These changes are expected to influence bird species that preferably feed on these grasshoppers. The observations at RWS suggest that the foraging strategy of a bird species and the nature/behaviour of its principle prey are important factors that govern the bird's foraging success and habitat use. For example, the Oriental Skylark was probably abundant in enclosures as its 'fast and agile pursuit' foraging strategy through grass was effective on *Acorypha* (abundant in ungrazed grassland), which took flight on the approach of predators. In contrast, Sykes's Crested Skylark, lapwings, and Indian Courser had an unhurried 'walk and pick-up prey' foraging strategy, which would not be effective in catching *Acorypha* and other agile prey species. Their foraging behaviour suggests that they prefer slow-moving prey that relies on camouflage to escape predators, such as *Chrotogonus* (abundant in grazed grassland). The diet of lapwings and coursers largely comprises slow-moving prey such as ants, beetles, caterpillars, and molluscs (Ali and Ripley 1987). Additionally, lapwings and coursers were observed to have difficulty in moving in the uniform tall grass of ungrazed grassland, which would further impact their foraging success. As for species-specific food preference, a captive chick GIB showed a clear preference for *Acorypha* (*c.* 5.5 cm long) over *Chrotogonus* (*c.* 2.5 cm long), and it stopped eating *Chrotogonus* after about four months of age (Manakadan and Rahmani 1990).

The importance of short grass for short grass dependant species has been established in some studies (Bock and Bock 1988; Nuttall 1993). Short grass increases visibility and improves mobility for catching prey, thus improving the foraging success for such species and thereby determining their habitat choice. This may explain why Montagu's Harrier was recorded foraging more in grazed grassland though its diet consisted largely of *Acorypha* (judging by analysis of regurgitated pellets). Montagu's Harrier probably finds detection and capture of *Acorypha* easier in the short grass of grazed grassland, even though this prey is more abundant in ungrazed grassland.

Another major factor determining the presence of bird species, especially shy skulkers, is their level of tolerance to human disturbance (see Burger 1981). In Rollapadu, the shy and secretive Lesser Florican was only recorded in Enclosure I (with males defending wintering/breeding territories each year), probably due to a combination of lack of disturbance, availability of grass cover, and food resources. GIB is partial to ungrazed grasslands due to lack of disturbance, but as discussed earlier, it requires a mosaic of grazed and ungrazed zones for different activities, which explains its occurrence in grazed grassland and high degree of variation in densities in the ungrazed grassland (Table 1). However, it is important to note that almost all of the 112 nests of GIB recorded between 1985 to1995 in RWS were in Enclosure I (Manakadan and Rahmani 1993, 1997).

Other factors influencing the occurrence of birds in the enclosures are more complex, such as predation and inter-specific competition. A significant increase in the population of the Indian Fox (Manakadan and Rahmani 2001) and Indian Monitor Lizard (Manakadan and Rahmani 1993, 1997) was reported after the establishment of the enclosures, which could cause an increase in predation on bird nests and chicks. The blackbuck population also increased from around 20 animals in 1985 to *c.* 500 in 1995 (Manakadan and Rahmani 1998), and their direct/indirect impacts on the grassland habitat and bird species is unknown. The increase in blackbuck population has had negative conservation implications due to crop-depredation and the resulting loss of support from locals (Manakadan and Rahmani 1993, 1997).

Implications of the Study

Grassland birds are reported to be declining in many countries, largely due to habitat loss and degradation (Goriup *et al.* 1991; Knopf 1994; Sauer *et al.* 2008; Tucker 1991; Vickery *et al.* 1999). The situation of Indian grasslands is serious because India with just a fortieth of the total land mass of the world supports more than 50% of its buffaloes, 15% of its cattle, 15% of its goats and 4% of its sheep, and additionally, lacks a grazing policy (see Rahmani 1988). Hence, urgent steps are required to be taken to protect India's grasslands.

One way of achieving this would be by setting up grazing and disturbance free grassland enclosures, which has proven to help in the conservation of two threatened bird species, namely the GIB and Lesser Florican, besides benefiting many other grassland fauna. In this study, some relatively common bird species were observed to largely confine themselves to the enclosures of RWS, suggesting that these were till then surviving in suboptimal conditions in the grazing lands.

Though the studies show that some grassland bird species have been adversely affected by the establishment of the enclosures, this should not be a cause for concern, as grazed grasslands are much more common than ungrazed grasslands in India. Additionally, there is an urgency to conserve grassland bird species that are threatened and intolerant to extreme grazing disturbances, and hence, managers should focus on setting up of grazing-free enclosures. However, care needs to be exercised on setting up enclosures in climatic or edaphic regions/conditions where the grass growth becomes too tall and dense, resulting in almost total habitat loss for most bird species, as was the case in Karera Bustard Sanctuary, Shivpuri district, Madhya Pradesh (Rahmani 1989). Furthermore, studies on the GIB (Rahmani 1988, 1989) have shown that this species needs a mosaic of habitats within an enclosure to cater to its different activities, life-cycles, and survival, so a judicious mix is necessary, depending on the focal

Table 1: Mean ±SD densities of grassland bird species in grazed and ungrazed grasslands of Rollapadu Wildlife Sanctuary

Species	Status	Dependence on Grassland	Diet (Ali and Ripley 1987) (In order of preference)	Grazed Grassland		Ungrazed Grassland	
				Mean Annual/ Seasonal Density (#/sq. km) Transect-I	Mean Annual/ Seasonal Density (#/sq. km) Transect-II	Mean Annual/ Seasonal Density (#/sq. km) Transect-I	Mean Annual/ Seasonal Density (#/sq. km) Transect-II
1. Black-shouldered Kite *Elanus caeruleus*	R	F	Insects, lizards, mice, sick birds	–	0.52 ±1.72	–	–
2. White-eyed Buzzard *Butastur teesa*	R	F	Insects, reptiles, birds	0.31 ±0.99	–	–	0.10 ±0.59
3. Pallid Harrier *Circus macrourus*	WM	O	Frogs, lizards, field mice, sick or young ground nesting birds, grasshoppers	0.20 ±0.81	0.98 ±2.29	0.20 ±0.81	0.20 ±0.81
4. Montagu's Harrier *Circus pygargus*	WM	O	As above, but see under Discussion	6.67 ±8.25	4.31 ±6.10	1.76 ±2.67	0.59 ±1.31
5. Common Kestrel *Falco tinnunculus*	WM	O	Insects	0.98 ±1.57	1.96 ±2.65	0.78 ±1.87	0.98 ±1.96
6. Rain Quail *Coturnix coromandelica*	SM	O	Grass seeds, insects	–	–	–	0.67 ±2.58
7. Common Quail *Coturnix coturnix*	SM	O	Grass seeds, insects	–	–	–	1.33 ±5.16
8. Great Indian Bustard *Ardeotis nigriceps*	R	O	Grasshoppers, beetles, other insects, reptiles, bird nestlings, small rodents	0.16 ±0.49	0.10 ±0.41	0.31 ±0.99	0.42 ±1.04
9. Lesser Florican *Sypheotides indicus*	SM	O	Insects	–	–	–	0.16 ±0.73
10. Indian Courser *Cursorius coromandelicus*	R	O	Beetles and their larvae, grasshoppers, crickets	13.13 ±24.02	15.31 ±22.57	–	–
11. Red-wattled Lapwing *Vanellus indicus*	R	F	Ants, beetles, caterpillars, insects, molluscs, vegetable matter	0.31 ±1.30	1.25 ±3.95	–	–
12. Yellow-wattled Lapwing *Vanellus malabaricus*	R	O	Grasshoppers, beetles	4.06 ±4.92	2.08 ±2.90	1.35 ±3.77	–
13. Chestnut-bellied Sandgrouse *Pterocles exustus*	R	O	Weed and grass seeds	1.98 ±6.21	5.63 ±18.31	7.08 ±19.19	6.04 ±9.63
14. Eurasian Collared-Dove *Streptopelia decaocto*	R	F	Seeds	1.56 ±2.54	2.08 ±3.25	4.48 ±5.96	3.02 ±4.00
15. Small Green Bee-eater *Merops orientalis*	R	F	Insects	–	–	1.04 ±3.92	–
16. Indian Roller *Coracias benghalensis*	R	F	Insects, reptiles, amphibians, rodents, birds	0.21 ±0.82	0.10 ±0.59	0.31 ±0.99	0.21 ±0.82

Table 1: Mean ±SD densities of grassland bird species in grazed and ungrazed grasslands of Rollapadu Wildlife Sanctuary (*contd.*)

Species	Status	Dependence on Grassland	Diet (Ali and Ripley 1987) (In order of preference)	Grazed Grassland		Ungrazed Grassland	
				Mean Annual/ Seasonal Density (#/sq. km) Transect-I	Mean Annual/ Seasonal Density (#/sq. km) Transect-II	Mean Annual/ Seasonal Density (#/sq. km) Transect-I	Mean Annual/ Seasonal Density (#/sq. km) Transect-II
17. Red-winged Bushlark *Mirafra erythroptera*	R	O	Insects	2.19 ±4.20	1.25 ±4.21	–	–
18. Ashy-crowned Sparrow-Lark *Eremopterix grisea*	R	O	Seeds, insects	50.63 ±35.92	59.06 ±51.58	7.81 ±11.28	20.31 ±23.35
19. Rufous-tailed Finch-Lark *Ammomanes phoenicurus*	R	O	Seeds, insects	0.94 ±3.90	1.56 ±7.23	–	–
20. Sykes's Crested Lark *Galerida deva*	R	O	Insects	36.25 ±38.75	22.50 ±22.72	5.63 ±11.90	8.13 ±15.95
21. Oriental Skylark *Alauda gulgula*	R	O	Insects	4.69 ±13.44	4.06 ±8.75	45.00 ±40.80	40.63 ±34.64
22. Greater Short-toed Lark *Calandrella brachydactyla*	WM	O	Seeds	–	1198.82 ±4467.51	–	157.06 ±610.00
23. Tawny Pipit *Anthus campestris*	WM	O	Insects	52.50 ±56.17	70.94 ±99.95	96.56 ±277.82	59.38 ±73.92
24. Paddyfield Pipit *Anthus rufulus*	R						
25. Common Swallow *Hirundo rustica*	WM	F	Aerial insects	1.18 ±3.32	1.18 ±3.32	12.94 ±33.12	3.33 ±5.14
26. Red-rumped Swallow *Hirundo daurica*	WM	F	Aerial insects	1.96 ±5.78	2.16 ±7.26	2.94 ±3.89	8.63 ±17.64
27. Southern Grey Shrike *Lanius meridionalis*	R	F	Insects, reptiles, birds, mammals	3.85 ±3.60	3.33 ±2.81	6.46 ±4.55	4.79 ±4.48
28. Zitting Cisticola *Cisticola juncidis*	R	O	Insects	–	–	13.44 ±23.64	15.00 ±18.49
29. Plain Prinia *Prinia inornata*	R	F	Insects	4.06 ±7.12	2.81 ±5.81	–	–
30. Indian Silverbill *Euodice malabarica*	R	F	Seeds, insects	–	1.25 ±4.92	–	9.06 ±21.61
31. Common Myna *Acridotheres tristis*	R	F	Insects, reptiles	0.21 ±1.18	0.31 ±1.30	2.60 ±7.07	2.92 ±4.38
32. Black Drongo *Edolius macrocercus*	SM	F	Insects, reptiles, birds, mammals	–	–	8.67 ±6.15	6.44 ±5.84

R = Resident (sanctuary and surrounding areas); WM = Winter Migrant: a visitor from the Palaearctic region; SM = Seasonal Migrant: a seasonal visitor from other regions of the Indian Subcontinent. O: Obligate – Entirely or almost entirely dependent on grasslands; F: Facultative – Uses grasslands as part of a wider array of habitats.

species to be conserved. In areas like Karera, some form of grazing/harvesting regime has to be implemented to check the excessive grass growth. Even in RWS, where grass growth is not much of a problem due to the shallow soil and aridity, clearing the growth of scrub, trees, and tall stands of *Sehima nervosum* grass has to be done once every few years (Manakadan *et al*. 2002).

Lastly, it is important to assess conservation issues of Indian grasslands at a landscape level, since these largely fall under human-impacted landscapes and will ultimately be influenced by the support and land-use practices of local communities, especially in the light of the problems arising from the growing human population and its impacts.

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FOOD HABITS OF INDIAN GREY HORNBILL *OCYCEROS BIROSTRIS* IN SATHYAMANGALAM FOREST DIVISION, EASTERN GHATS, INDIA

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The foraging ecology of Indian Grey Hornbill *Ocyceros birostris* was studied in Sathyamangalam Forest Division, Eastern Ghats, from 2006 to 2008. Its diet in the breeding season was assessed by 720 hours of direct observations of food deliveries to 10 different nest inmates and by nest midden analysis. Observations at nest holes revealed that males visited nests an average of 16 times per day, and the food items delivered to the nest inmates (female and chicks) included both plant (63.7%) and animal matter (36.3%). Fleshy fruits of 14 species were delivered, and the animal matter was mainly insects (99%). Seeds collected from the nest middens on analysis showed the presence of 26 fruit species of 16 plant families. Food habits of this hornbill during the non-breeding season were assessed by walking along transects and observing foraging activities. Of the 3,086 feeding observations obtained, 83% were on fruits and the rest were on leaves (8.8%), insects (7.7%), and flowers (0.5%). Of the 38 fruit species eaten, *Ficus* spp. constituted 25.3% of the non-breeding season fruit diet. In all, fruits of 41 species of 21 families were recorded in the diet. The study revealed that both fig and non-fig species are important for the survival of the Indian Grey Hornbill in the Eastern Ghats.

Key words: Hornbill, Indian Grey Hornbill, figs, frugivory, fruit preferences, nest midden

INTRODUCTION

Food selection is an important aspect of understanding the relationships between frugivorous animals and fruiting plants, because their interactions are important in the maintenance and regeneration of flora (Janzen 1970). Studies on frugivore diets are extremely valuable as they help outline the potential interactions between bird-dispersed plants and fruit-eating birds. Hornbills are among the major avian frugivores and seed dispersers in tropical forests (Kemp 1995). Asian hornbills are generally frugivorous, but turn omnivorous in the breeding season (Poonswad *et al.* 1998). Although many consume a diversity of animal prey, both vertebrates and invertebrates, the bulk of the diet by weight and nutrition rewards come from fruits (Kinnaird and O'Brien 2007). The interactions between frugivorous hornbills and fruiting plants have received considerable attention.

Although detailed studies on food and feeding habits of various Asian hornbills have been conducted (Balasubramanian and Maheswaran 2002; Balasubramanian *et al.* 2004; Datta and Rawat 2003; Kannan and James 1997; Kinnaird *et al.* 1996; Leighton 1982; Mudappa 2000; Poonswad and Tsuji 1994; Poonswad *et al.* 1998; Suryadi *et al.* 1994), information on one of the most common species in the Indian subcontinent, namely the Indian Grey Hornbill *Ocyceros birostris*, has been inadequate. The species is distributed in India, Pakistan, and Nepal (Ali and Ripley 1987), occurring in deciduous biotopes, open thorn forests, and rural cultivated areas (Ali and Ripley 1987; Kemp 1995). In southern India, it occurs along the entire stretch of Eastern Ghats and in the foothill forests of Western Ghats (Balasubramanian *et al.* 2005). Anecdotal observations on the species were made by Hall (1918) and Patil *et al.* (1997), providing preliminary observations on their dietary habits during the breeding season. Kasambe (2011) carried out a detailed study on the food habits and breeding ecology of this species in Central India, but this study was from an urban landscape. Hence, we undertook a study on the Indian Grey Hornbill to assess the species' food and feeding habits and fruit preferences during the breeding and non-breeding seasons in a forest landscape in the Eastern Ghats from 2006 to 2008.

STUDY AREA

The Eastern Ghats is an important habitat for diverse biota across the east coast of India, traversing the states of Odisha, Andhra Pradesh, Tamil Nadu, and a small part of Karnataka. The Eastern Ghats is a "poor relation" of the Western Ghats, being less heavily forested and disjointed in many sections due to a number of large rivers flowing across. These rivers divide the Eastern Ghats into a number of distinct hill regions, endowing each section with its own unique characteristics. Sathyamangalam Forest Division

(11° 43' 11" N; 77° 27' 22" E; 1,455 sq. km) lies in the southernmost stretch of the Eastern Ghats, in Erode district of Tamil Nadu. This division, along with tracts of adjoining forests, was declared as the Sathyamangalam Wildlife Sanctuary and Tiger Reserve (1,408.41 sq. km) in 2011.

Hasanur Range of Sathyamangalam Forest Division (164.86 sq. km), where the study was carried out, receives rainfall from both the southwest and northeast monsoon, varying from 600 to 850 mm per annum. The elevation is *c.* 490 m above mean sea level. The temperature is high (40 °C) during summer and low (20 °C) during winter nights. The vegetation at the study site mainly comprised dry deciduous forests in the plateau and semi-evergreen forests along the streams and rivers. Sandalwood *Santalum album* and bamboo *Bambusa arundinacea* are dominant species in the dry forests. Riparian forests are dominated by *Terminalia* spp., *Mangifera indica*, *Syzygium cumini*, *Melia dubia*, and *Ficus* spp.

METHODS

Food habits

Data was gathered for two breeding and non-breeding seasons from July 2006 to June 2008. In the breeding season (March to May) at Sathyamangalam, 32 active nest trees were located by following breeding pairs or on observing breeding males carrying food to nests. From these, a few focal males and nest middens were studied to document the diet of the species during the breeding season. This data was obtained from systematic observations of feeding birds while walking along transects. Details of the sampling during the breeding and non-breeding seasons are discussed below.

Remains of food items consumed by nest inmates (mother and young) are generally squirted out through the nest slit, which get deposited beneath the nest tree as middens, which include seeds, undigested parts of plant and animal food, and nesting material. The middens of 10 nests (five nests per year) were examined and analyzed once a week during the nesting period. Very small seeds (e.g., fig seeds <2 mm) were not taken into account. The seeds collected from middens were compared with other seeds of fruits collected from the study area to confirm the identity of the species. The midden area was cleaned after each collection.

Extended observations were also carried out at 10 nests (five nests per year) to assess the food utilized during the breeding season. A total of 720 hours (360 hours per year, 72 hours per nest) were spent in hides set up near nests to record food delivery by males to nest inmates. Observations were carried out from 06:00 hrs to 18:00 hrs. During nest monitoring the number of visits made by the male, food items delivered, and number of items delivered per visit were recorded. To determine the percentage composition of plant and animal food required for the nest inmates to complete the breeding cycle, we distinguished the nesting period into two main phases: the pre-hatching and the post-hatching phase. The mean duration of nesting period was 87 ±2 days, the young hatched in an average of 30 ±2 days (pre-hatching phase) from the day of incarceration of the female. The post-hatching phase was 57 ±3 days (Santhoshkumar and Balasubramanian 2010). The pre-hatching and post-hatching phase could be distinguished based on calls of chicks heard from nests, especially when the male approached the nest to pass on the food to the female.

During the non-breeding season, observations were done along two transects, mostly from 06:00 hrs to 10:00 hrs and 15:00 hrs to 18:00 hrs when the feeding activity of hornbills is high (Balasubramanian *et al.* 2004). During the transect walk, birds sighted within 50 m on either side of the transect were recorded. During each sighting, the tree species in which hornbills were feeding and food item consumed were recorded. Since fruits form the major diet of hornbills (Ali and Ripley 1987; Balasubramanian *et al.* 2004), efforts were made to determine their preferred fruit species in Sathyamangalam.

Food Availability

Vegetation sampling was done in the two main vegetation types, namely dry deciduous forest and riparian forest to enumerate the availability of woody species, mainly trees, which would serve as an index on the availability of fruiting trees to the hornbill. In dry deciduous forest, a 1 ha plot (100 x 100 m) was laid, and subdivided into 100 sub-plots of 10 x 10 m. In the riparian forest, a 1 ha belt transect (1000 x 10 m) was laid along the river bank and subdivided into 100 sub-plots of 10 x 10 m. In both the habitats, woody plants measuring >20 cm GBH (girth at breast height) within the sub-plots were measured and recorded. This vegetation data was analyzed to obtain quantitative values of the density, abundance, and frequency, using standard formulae.

Fruiting phenology was monitored by tagging 210 plants belonging to 21 fleshy-fruited species for two years from July 2006 to June 2008. Tagged plants were monitored once in a fortnight to record fruit availability. Percentage of fruit in the canopy was visually estimated and divided into percentages of ripe and unripe fruits, based primarily on colour changes indicating ripeness (Anggraini *et al.* 2000; Balasubramanian *et al.* 2004).

Table 1: Proportion of plant and animal matter consumed by Indian Grey Hornbill in Sathyamangalam Forest Division, Eastern Ghats

		Breeding season		Non-breeding season	
		% utilized		% utilized	
		Ist year	IInd year	Ist year	IInd year
I.	Plant matter				
	Fruits				
	Figs	30.44	23.77	39.05	37.90
	Non-figs	13.76	48.79	39.86	41.26
	Leaves	1.56	0.86	10.39	10.87
	Flowers	-	-	1.29	-
II.	Animal matter				
	Insects	53.91	26.38	9.42	9.96
	Eggs	0.23	0.08	-	-
	Lizards	0.06	0.10	-	-
	Others (chicks, snakes, rodents)	0.04	0.02	-	-

Statistical Analysis

Preference Index (PI) was calculated using Ivlev's Index of Selectivity (Ivlev 1961), (PI= U-A/U+A, where U denotes utilization of the species and A denotes availability of corresponding species). Availability of the fruit tree species was estimated from the vegetation sampling data. Utilization of the species was obtained from the number of feeding observations recorded. Values of PI range between -1 and +1, where -1 indicates avoidance, while +1 indicates highest preference.

The food items brought to the nest were classified into figs, non-figs, and animal matter. The proportion of different food items consumed was tested with Chi-square test. The difference in food items consumed between the pre-hatching and post-hatching phases of nesting period was tested for statistical significance using t-test.

RESULTS

Breeding Season Diet

During nest monitoring, 13,680 food items were observed being delivered to the 10 focal nests. Food items delivered comprised both plant (63.7%) and animal matter (36.3%). The animal diet was mainly insects (99%), the rest comprised lizards, snakes, and rats. The plant diet was mainly fruits (98.3%) with a small proportion of *Melia dubia* leaves. Among the fruits delivered, figs formed the majority (26%), followed by *Premna tomentosa* (25%). While figs were available throughout the year, fruiting of *Premna tomentosa* was restricted to three months (May to July) towards the end of the breeding season.

Yearwise comparison showed that fig consumption did not show much difference between the two years of study (Table 1). Non-figs comprised 14% of the diet in the first year, and 49% in the second year. Animal matter constituted 54% in the first year, and 26% in the second year (Table 1). The increase in the consumption of non-figs in the second year could be due to high fruiting of *Premna tomentosa*, considering that it constituted 25% of the diet during the breeding season. The major portion of the animal diet in the first year was cicadas; in the second year only a few insects were delivered to the nest inmates.

Fruits of 26 plant species were consumed by the hornbills during the breeding season: 14 species recorded while monitoring food deliveries to nests and 12 from nest middens. The preferred fruit species included six species of figs, and a few non-figs, namely *Premna tomentosa*, *Santalum album*, and *Solanum erianthum* (Table 2).

The food items delivered to the nest inmates were classified into figs, non-figs, and animal matter. A comparison of diet composition of pre-hatching phase and post-hatching phase in the breeding season indicated a predominance of animal food in the post-hatching phase, and figs in the pre-hatching phase. The proportion of non-fig and animal matter delivered to the nest inmates was significantly higher (t-test, $t = -3.508$, $df = 57$, $p<0.01$ and $t = -4.133$, $df = 79$, $p<0.01$) in the post-hatching phase than the pre-hatching phase.

Non-breeding Season Diet

Based on 3,086 feeding observations, the diet of the Indian Grey Hornbill during the non-breeding season was found to comprise fruits (83%), leaves (8.8%), flowers (0.5%), and insects (7.7%). It fed on a total of 38 fruit species (21 families), of which six species of *Ficus* (*Ficus benghalensis*, *F. drupacea*, *F. infectoria*, *F. microcarpa*,

Table 2: Preference index of food plant species of Indian Grey Hornbill in Sathyamangalam Forest Division, Eastern Ghats

S.No	Plant species	Preference Index (PI)	
		Breeding season	Non-breeding season
1.	*Bridelia crenulata*	-	0.97
2.	*Canthium dicoccum*	-	-0.11
3.	*Capparis grandis*	-	0.50
4.	*C. sepiaria*	-	-0.61
5.	*Celtis tetrandra*	-	0.91
6.	*Clausena dentata*	-	0.70
7.	*Diospyros montana*	0.06	0.73
8.	*Drypetes roxburghii*	-	0.94
9.	*Erythroxylum monogynum*	-	-0.83
10.	*Ficus benghalensis*	0.97	0.90
11.	*F. drupacea*	0.78	0.94
12.	*F. infectoria*	0.92	0.96
13.	*F. microcarpa*	0.99	0.93
14.	*F. racemosa*	0.96	0.91
15.	*F. religiosa*	0.93	0.95
16.	*Ixora pavetta*	-	-0.30
17.	*Lantana camara*	-0.95	-0.97
18.	*Mimusops elengi*	-	0.83
19.	*Naringi crenulata*	-	-0.50
20.	*Premna tomentosa*	0.99	0.71
21.	*Santalum album*	0.98	0.93
22.	*Schleichera oleosa*	-	0.67
23.	*Solanum erianthum*	0.96	0.95
24.	*Syzygium cumini*	-	0.71
25.	*Vitex altissima*	-	0.45
26.	*Ziziphus mauritiana*	-	-0.05
27.	*Z. oenoplia*	-	0.81

F. racemosa, and *F. religiosa*) constituted 25% of the 3,086 feeding observations. Non-figs such as *Diospyros montana* (9%) and *Vitex altissima* (7%) were also major food. The hornbills were also recorded feeding on the leaves of *Melia dubia* and *Ailanthus excelsa*, and a few observations showed feeding on *Vitex altissima* flowers. Cultivated fruit species such as *Pithecellobium dulce*, *Carica papaya*, *Morus alba*, *Psidium guajava*, and *Muntingia calabura* were also eaten (4%). There was not much difference in the non-breeding season diet between the two years (Table 1). Ivlev's preference index showed that Indian Grey Hornbill's preferred species in the non-breeding season were *Bridelia crenulata* (0.97), *Ficus religiosa* (0.95), and *Solanum erianthum* (0.95) (Table 2).

Overall, fruits constituted 79.03% of the diet in non-breeding season and 58.38% in the breeding season, these comprising 41 species of fleshy fruits belonging to 21 families (Appendix 1).

DISCUSSION

Studies by Hall (1918), Patil *et al.* (1997), and Kasambe (2011) reported that fruits are an important component in the diet of Indian Grey Hornbill during the breeding season. Whitney *et al.* (1998) reported that fruits comprised over 90% of the diet of *Ceratogymna* hornbills in Daj Reserve, Cameroon. Fruits constitute a major portion of the dietary requirements of Asian hornbills (Kinnaird and O'Brien 2007). In our study on the Indian Grey Hornbill in Sathyamangalam Forest Division, the species was recorded to feed on the fruits of 41 species from 21 families.

Many studies on the food habits of hornbills show a high proportion of figs in their diet (Table 3), which was also true in our study, where figs comprised 26% of the diet during the breeding season and 25% during the non-breeding season; six species of figs were found to be highly preferred. Suryadi *et al.* (1994) observed that figs

Table 3: Proportion of figs in the diet of hornbill species in Asia

Species	Study area	% of figs	Methodology	Reference
Brown Hornbill *Anorrhinus tickelli*	Thailand	21	Wet weight of fruits	Poonswad *et al.* (1986)
Bushy-crested Hornbill *Anorrhinus galeritus*	Indonesia	66	Wet weight, fruit type and endosperm character	Hadiprakarsa and Kinnaird (2004)
Great Hornbill *Buceros bicornis*	Thailand	57	Wet weight of fruits	Poonswad *et al.* (1986)
Great Hornbill *Buceros bicornis*	Western Ghats, India	73	Direct observations at nest and nest midden analysis	Kannan and James (1997)
Great Hornbill *Buceros bicornis*	Thailand	57	Wet weight of fruits	Poonswad *et al.* (1986)
Helmeted Hornbill *Buceros vigil*	Indonesia	98	Wet weight, fruit type and endosperm character	Hadiprakarsa and Kinnaird (2004)
Malabar Grey Hornbill *Ocyceros griseus*	Western Ghats, India	26	Observations at focal nest and middens	Mudappa (2000)
Malabar Grey Hornbill *Ocyceros griseus*	Western Ghats, India	62	Direct observations and midden analysis	Balasubramanian and Maheswaran (2002)
Malabar Pied Hornbill *Anthracoceros coronatus*	Western Ghats, India	75	Direct observations and midden analysis	Balasubramanian *et al.* (2004)
North Sulawesi Tarictic Hornbill *Penelopides exarhatus exarhatus*	North Sulawesi, Indonesia	34	Focal observation at nests	O'Brien (1997)
Oriental Pied Hornbill *Anthracoceros albirostris*	Arunachal Pradesh, India	47	Direct observations and seed count	Datta and Rawat (2003)
Oriental Pied Hornbill *Anthracoceros albirostris*	Thailand	35	Wet weight of fruits	Poonswad *et al.* (1986)
Rhinoceros Hornbill *Buceros rhinoceros*	Indonesia	77	Wet weight, fruit type and endosperm character	Hadiprakarsa and Kinnaird (2004)
Rufous-necked Hornbill *Aceros nipalensis*	Thailand	18	Observations at focal nest and midden analysis	Chimchome *et al.* (1998)
Sulawesi Red-knobbed Hornbill *Aceros cassidix*	North Sulawesi, Indonesia	83	Fruit weight, size and colour	Suryadi *et al.* (1994)
Sulawesi Red-knobbed Hornbill *Aceros cassidix*	North Sulawesi, Indonesia	69	Observations at focal nest	Kinnaird and O'Brien (1993)
Sulawesi Red-knobbed Hornbill *Aceros cassidix*	North Sulawesi, Indonesia	81	Fruit biomass	Kinnaird and O'Brien (1999)
Wreathed Hornbill *Aceros undulatus*	Indonesia	64	Wet weight, fruit type and endosperm character	Hadiprakarsa and Kinnaird (2004)
Writhed-billed (sic) Hornbill *Aceros waldeni*	Philippines	Over one-third of food at nest	Direct observations at nest	Kauth *et al.* (1998)

were available throughout the year and were preferred by Sulawesi Red-knobbed Hornbill *Aceros cassidix* in the non-breeding season in the Tangkoko-Dua Sudara Reserve, North Sulawesi, Indonesia. Kanwatanakid *et al.* (2009) studied the food overlap between gibbons and four species of hornbills (Great Hornbill *Buceros bicornis*, Wreathed Hornbill *Rhyticeros undulatus*, Oriental Pied Hornbill *Anthracoceros albirostris*, and White-throated Brown Hornbill *Anorrhinus austeni*) in Thailand, and reported a higher component of figs, as well as animal matter in the breeding season diet of hornbills. Reddy and Basalingappa (1993) and Balasubramanian *et al.* (2004) reported that figs were one of the most preferred fruits of Malabar Pied Hornbill *Anthracoceros coronatus* in the Western Ghats.

Non-fig fruit species also formed a substantial part of the Indian Grey Hornbill's diet in Sathyamangalam Forest Division, with *Santalum album* and *Premna tomentosa* being highly preferred. Poonswad *et al.* (1983) reported that 45% of the fruits consumed by Oriental Pied Hornbill *Anthracoceros albirostris* in Thailand during the breeding season were non-figs. Kinnaird and O'Brien (1993) reported that 20% of the breeding season diet of Red-knobbed Hornbill comprised non-fig species. Kannan and James (1997) found *Vitex altissima* and *Strychnos nux-vomica* to be important food plants of the Great Hornbill *Buceros bicornis* in the Western Ghats. Balasubramanian *et al.* (2004) reported that 20% of the non-breeding season diet and 21% of the breeding season diet of Malabar Pied Hornbill in the Western Ghats comprised non-fig species.

In our study, we recorded that the Indian Grey Hornbill utilizes a higher proportion of animal food during the breeding season, particularly during the post-hatching phase. Poonswad *et al.* (1986) reported that 14% of the non-breeding season food of the Great Hornbill comprised animal matter. Animal food formed nearly 10% of the diet of *Ceratogymna* hornbills in Daj Reserve, Cameroon (Whitney *et al.* 1998). According to Mudappa (2000), the utilization of animal food in the post-hatching phase could be to provide the growing chicks with high quality food having essential nutrients.

Leaves in the diet of Indian Grey Hornbill have received some attention. Hall (1918) recorded Indian Grey Hornbill delivering green leaves to the nest inmates in Gurdaspur, Punjab. Patil *et al.* (1997) studied the excreta contents of the Indian Grey Hornbill and listed various food items including green leaves of unknown species in Sanjay Gandhi National Park, Mumbai, Maharashtra. Kasambe and Pimpalapure (2007) observed Indian Grey Hornbill plucking and swallowing the leaves of *Ailanthus excelsa* in Maharashtra. In our study, we observed Indian Grey Hornbills feeding on the leaves of *Melia dubia* and *Ailanthus excelsa* on a few occasions during the non-breeding season. In the breeding season, leaves of *Melia dubia* being fed to the nest inmates were recorded. The probable reason for feeding the nest inmates with leaves could be to supply low energy food to the female, who does not require higher nutrition, as she is totally confined to the nest during this period.

CONCLUSION

Overall, our findings showed that figs, non-figs, and animal matter constitute the diet of Indian Grey Hornbill in the Sathyamangalam forests, southern Eastern Ghats. Among these, fruits constituted the major proportion of the diet, both in the breeding and non-breeding season. Hence, conservation of fleshy-fruited plant species (see species listed in Appendix 1) is vital for the survival of the species.

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Appendix 1: Fruit species recorded in the diet of Indian Grey Hornbill in Sathyamangalam Forest Division, Eastern Ghats, India

S. No	Species	Fruiting season	
		Breeding season	Non-breeding season
	Boraginaceae		
1.	*Cordia monoica* Roxb.	+	+
2.	*Cordia obliqua* Willd.	+	+
	Caesalpiniaceae		
3.	*Pithecellobium dulce* (Roxb.) Benth.	+	+
	Capparidaceae		
4.	*Capparis grandis* L.f.	+	+
5.	*Capparis sepiaria* L.	-	+
	Caricaceae		
6.	*Carica papaya* L.	+	+
	Celastraceae		
7.	*Euonymus indicus* Heyne ex Wallich	-	+
	Ebenaceae		
8.	*Diospyros montana* Roxb.	+	+
	Erythroxylaceae		
9.	*Erythroxylum monogynum* Roxb.	-	+

Appendix 1: Fruit species recorded in the diet of Indian Grey Hornbill in Sathyamangalam Forest Division, Eastern Ghats, India (*contd.*)

S. No	Species	Fruiting season	
		Breeding season	Non-breeding season
	Euphorbiaceae		
10.	*Bridelia crenulata* Roxb.	-	+
11.	*Drypetes roxburghii* (Wallich) Hurusawa	+	+
	Loganiaceae		
12.	*Strychnos potatorum* L.f.	+	-
	Moraceae		
13.	*Ficus benghalensis* L.	+	+
14.	*Ficus drupacea* Thunb.	+	+
15.	*Ficus infectoria* Roxb.	+	+
16.	*Ficus microcarpa* L.f.	+	+
17.	*Ficus racemosa* L.	+	+
18.	*Ficus religiosa* L.	+	+
19.	*Morus alba* L.	+	+
	Myrtaceae		
20.	*Psidium guajava* L.	-	+
21.	*Syzygium cumini* (L.) Skeels	+	+
	Rhamnaceae		
22.	*Scutia myrtina* (Burm.f.) Kurz	-	+
23.	*Ziziphus mauritiana* Lam.	+	+
24.	*Ziziphus oenoplia* (L.) Miller	-	+
	Rubiaceae		
25.	*Psydrax dicoccos* (Gaertner) Teijsm. & Binnend	-	+
26.	*Ixora pavetta* Andrews	-	+
	Rutaceae		
27.	*Atalantia monophylla* (L.) Corr. Serr.	+	-
28.	*Naringi crenulata* (Roxb.) Nicolson	-	+
29.	*Clausena dentata* (Willd.) Roemer	-	+
	Sapindaceae		
30.	*Filicium decipiens* (Wight & Arn.) Thwaites	+	+
31.	*Schleichera oleosa* (Lour.) Oken	-	+
	Sapotaceae		
32.	*Mimusops elengi* L.	+	-
	Santalaceae		
33.	*Santalum album* L.	+	+
	Solanaceae		
34.	*Solanum erianthum* D. Don	+	+
35.	*Solanum violaceum* Ortega	-	+
	Tiliaceae		
36.	*Grewia tiliifolia* Vahl	-	+
37.	*Muntingia calabura* L.	-	+
	Ulmaceae		
38.	*Celtis tetrandra* Roxb.	+	+
	Verbenaceae		
39.	*Lantana camara* L.	+	+
40.	*Premna tomentosa* Willd.	+	+
41.	*Vitex altissima* L.f.	+	+

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NEW RECORD OF LIVE CORAL SPECIES COLONIZING INTERTIDAL ZONES ALONG SOUTHERN SAURASHTRA, INDIA

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The intertidal zone of southern Saurashtra shows a great deal of marine biodiversity. However, the coral diversity was negligible earlier as the coastline is muddy or sandy with occasional rocky outcrops. The diversity of other cnidarians like zoantharians was also low along this coastline. However, this scenario has changed over the last few years. A number of changes in the macrofaunal diversity were observed in the vertical zones of the intertidal area off this coastline, including the invasion of zoantharians and different coral species into the intertidal zone. The present communication reports the cropping up of new colonies of hard corals in the intertidal zone of the shores along the south Saurashtra coastline, India. Eight species of scleractinian corals belonging to four families and six genera were recorded from the intertidal zone of this coastline. Diversity, distribution, and taxonomic features based on morphology and corallite structures are described. Most of the colonies were small to medium and appeared to be not more than a few years old. These species are recorded for the first time from the south Saurashtra coastline off the Kathiawar Peninsula.

Key words: Intertidal zone, coral diversity, new record, south Saurashtra coastline, Gujarat, India

INTRODUCTION

Saurashtra region is located in southwest Gujarat, India, and occupies a total coastal stretch of 865 km. The Dwarka to Diu segment of south Saurashtra coastline is *c.* 300 km long with sandy and rocky-muddy intertidal zone. Tides in this area are mixed and semidiurnal type, with large diurnal variation. Literature survey indicated that the published reports on intertidal macrofauna along this long coastline are not very significant. Most of the reports dealt with the diversity and population ecology of molluscs and arthropods (Prasad 1984). Published reports on corals and other lower invertebrates are also few (Patel 1984). This is possibly due to the nature of this coastline which is muddy or sandy, with occasional rocky outcrops (Malli 1993). Corals and other cnidarians were rare along this coastline (Misra and Kundu 2005). This scenario was, however, found to be changing over the last few years. Small and newly established live coral colonies were visible in all littoral zones (Bhadja 2010; Poriya 2010; Vaghela 2010). It has also been observed that large areas of the upper and middle littoral zones of rocky-muddy coastlines are now significantly occupied by *Zoanthus sansibaricus*, replacing the algal vegetation which was once thriving in these zones (Desai 1987). Large numbers of small coral colonies are common these days in almost all rocky shores along the South Saurashtra coastline.

During the present study, intertidal zones of four different coasts, namely Dwarka, Mangrol, Veraval, and Diu were intensively surveyed for coral diversity from January to November, 2012. There is plenty of literature on taxonomy, distribution, and diversity of corals in the Gulf of Kachchh (Deshmukhe *et al.* 2000; Hornell 1909; Patel 1978, 1985; Pillai 1983, 2010; Pillai and Patel 1988; Rashid 1985). However, very few reports are available for the coastline of South Saurashtra. Raghunathan *et al.* (2004) conducted a survey of coral diversity along the Saurashtra coastline and recorded four species *Polycyathus verrilli*, *Porites lutea*, *Tubastrea aurea*, and *Turbinaria crater* in the intertidal zone from Dwarka, Veraval, Diu, and Mahuva. The present study was undertaken to explore the diversity of live coral species along the coastline of South Saurashtra.

MATERIAL AND METHODS

In the present survey, four different coasts, namely Dwarka (22° 13′ N; 68° 58′ E), Mangrol (21° 07′ N; 70° 07′ E), Veraval (21° 35′ N; 69° 36′ E), and Diu (20° 42′ N; 71° 01′ E) were selected for the study. The intertidal zone of Dwarka bears large rocks and boulders. The rocky portion is sharp-edged, with abundant tiny pools and puddles. The intertidal belt of Mangrol is uniform and rocky with many small to medium tide pools, puddles, and crevices. The upper zone of this intertidal belt is covered with sandy silt and studded with pieces of broken molluscan shells. The intertidal zone of Veraval coast is mainly rocky with a few sandy patches. However, this coast does not have a significantly long tidal exposure since the lower littoral zone ends as a steep vertical decline towards the subtidal zone. The intertidal belt at Diu has large rocks and boulders together with many small channels, pools, and puddles. At Veraval and Diu, the intertidal area that is exposed during low tide has large rock pools with partially exposed rock.

From January 2012 to November 2012, surveys were conducted at all the locations during the lowest tide. Photographs of the corals were taken *in situ*, and small portions of the colonies were collected for further identification. A portion of each collected sample was bleached with Hypochlorite solution to expose the corallite structure required for identification. All the observed coral species were identified up to species level by comparing differences in morphology, size, and colour with identification keys and other literature (Coles 1996; Patterson *et al.* 2004; Veron 2000; Veron and Pichon 1976, 1980, 1982; Veron and Wallace 1984), manuals (Venkataraman and Satyanarayana 2012) and with extensive web search.

RESULTS

Eight species of hard corals belonging to four families and six genera were recorded from the intertidal zone of South Saurashtra (Figs 1–8). Three species of two genera from family Poritidae, three species of two genera from family Siderastreidae, one species of one genus from Acroporidae and one species of one genus from Dendrophylliidae were identified. Small to large patches of *Porites* species were found to be abundant throughout the selected coastline, while other species were found to be unevenly distributed. Small colonies of *Pseudosiderastrea tayami* were also recorded at all the locations, while *Montipora venosa*, *Psammocora vaughani* and *Turbinaria peltata* were recorded only from Diu (Table 1).

Taxonomic position of the corals of Order Scleractinia (Bourne, 1900)

1. *Goniopora columna* (Dana, 1846)

Family: Poritidae (Gray, 1842)

Table 1: Site wise distribution and status of observed coral species

Sr. No.	Coral species	Reported in GoK/ Saurashtra	Dwarka	Mangrol	Veraval	Diu
1.	*Goniopora columna* (Dana, 1846)	+ / -	++ S M, L	-	++ S M, L	+++ S,Lg U, M, L
2.	*Porites lutea* (Milne Edwards and Haime, 1851)	+ / +	++ S, Lg U,M,L	+ S M,L	+++ S, Lg U,M,L	++ S U,M
3.	*Porites stephensoni* (Crossland, 1952)	- / -	++ S M, L	+ S M	+++ S, Lg U, M, L	+ S U, M
4.	*Psammocora superficialis* (Gardiner, 1898)	+ / -	+ S M, L	+ S M, L	++ S, Lg M, L	-
5.	*Psammocora vaughani* (Yabe and Sugiyama, 1936)	- / -	-	-	-	+ Lg L
6.	*Pseudosiderastrea tayami* (Yabe and Sugiyama, 1935)	+ / -	++ S M, L	+ S M, L	++ S M, L	+++ S U, M, L
7.	*Montipora venosa* (Ehrenberg, 1834)	+ / -	-	-	-	+ Lg M
8.	*Turbinaria peltata* (Esper, 1794)	+ / -	-	-	-	+ M L

*Abbreviations used: '+' Rare; '++' Common; '+++' Abundant; '-' Absent;
'S' Small colony; 'Lg' Large colony;
'U' Upper Littoral Zone; 'M' Middle Littoral Zone; 'L' Lower Littoral Zone; 'GoK' Gulf of Kachchh

Genus: *Goniopora* (Blainville, 1830)

Specimen: *Goniopora columna* (Dana, 1846)

Taxonomic references: Veron and Pichon (1982), Veron (2000), Venkatraman and Satyanarayana (2012).

IUCN Red List Category (2014): Near Threatened.

Description: Colonies are encrusting with short columns. Corallites are rounded or polygonal. Corallites near the upper surface of columns have fine irregular septa and diffused columellae. Tentacles are light brown with white oral disc (Fig. 1).

Distribution: This species is found in the Red Sea, Gulf of Aden, southwest, northwest and northern Indian Ocean, Arabian/Iranian Gulf, central Indo-Pacific and west Pacific Ocean, north, west and eastern Australia, Southeast Asia, Japan and East China Sea (IUCN 2014). This is a new record from the Saurashtra coastline.

2. *Porites lutea* (Milne Edwards and Haime, 1851)

Family: Poritidae (Gray, 1842)

Genus: *Porites* (Link, 1807)

Specimen: *Porites lutea* (Milne Edwards and Haime, 1851)

Taxonomic references: Veron and Pichon (1982), Veron (2000), Patterson *et al.* (2004), Venkatraman and Satyanarayana (2012).

IUCN Red List Category (2014): Least Concern.

Description: Colonies are hemispherical and helmet-shaped and form micro atolls in intertidal habitats. Corallites are filled with skeletal structures (Fig. 2).

Distribution: This species is found in the Red Sea, Gulf of Aden, southwest and northern Indian Ocean, Persian Gulf, the central, eastern and west Pacific Ocean, east, west and north Australia, Southeast Asia, Japan and south China Sea, Hawaiian Islands and Johnston Atoll (IUCN 2014). This species was previously reported from Gulf of Kachchh (Patel 1978; Pillai 1983; Pillai and Patel 1988) and Saurashtra (Raghunathan *et al.* 2004).

3. *Porites stephensoni* (Crossland, 1952)

Family: Poritidae (Gray, 1842)

Genus: *Porites* (Link, 1807)

Specimen: *Porites stephensoni* (Crossland, 1952)

Taxonomic references: Veron and Pichon (1982), Veron (2000).

IUCN Red List Category (2014): Near Threatened.

Description: Colonies are encrusting, hemispherical, or columnar and are usually less than 0.1 m. Corallites are filled with skeletal structures (Fig. 3).

Distribution: This species is found in the Red Sea, Sri Lanka, central Indo-Pacific and west Pacific Ocean, west, north and east Australia, Southeast Asia, southern Japan and South China Sea (IUCN 2014). This is a new record from the Gujarat coast.

4. *Psammocora superficialis* (Gardiner, 1898)

Family: Siderastreidae (Vaughan & Wells, 1943)

Genus: *Psammocora* (Dana, 1846)

Specimen: *Psammocora superficialis* (Gardiner, 1898)

Taxonomic references: Veron and Pichon (1976), Veron (2000), Venkatraman and Satyanarayana (2012).

IUCN Red List Category (2014): Least Concern.

Description: Colonies are encrusting with low irregular ridges, and bright green. Corallites are small and irregularly distributed. Primary septo-costae have petaloid shape (Fig. 4).

Distribution: This species is found in the Red Sea, Gulf of Aden, southwest, northwest, and north Indian Ocean, Arabian/Iranian Gulf, central Indo-Pacific and Pacific Ocean, Australia, Southeast Asia, Japan and east China Sea, Hawaiian Islands, and Johnston Atoll (IUCN 2014). This species is a new record from the Saurashtra coastline.

5. *Psammocora vaughani* (Yabe and Sugiyama, 1936)

Family: Siderastreidae (Vaughan & Wells, 1943)

Genus: *Psammocora* (Dana, 1846)

Specimen: *Psammocora vaughani* (Yabe and Sugiyama, 1936)

Taxonomic references: Veron and Pichon (1976), Veron (2000).

IUCN Red List Category (2014): Near Threatened.

Description: Colonies are sub-massive or encrusting. Corallites are in groups in shallow depressions. Septo-costae are thick, compressed, with granulated margins (Fig. 5).

Distribution: This species is found in Japan, east China Sea and west Pacific Ocean (IUCN 2014). This is a new record from the Gujarat coastline.

6. *Pseudosiderastrea tayami* (Yabe and Sugiyama, 1935)

Family: Siderastreidae (Vaughan & Wells, 1943)

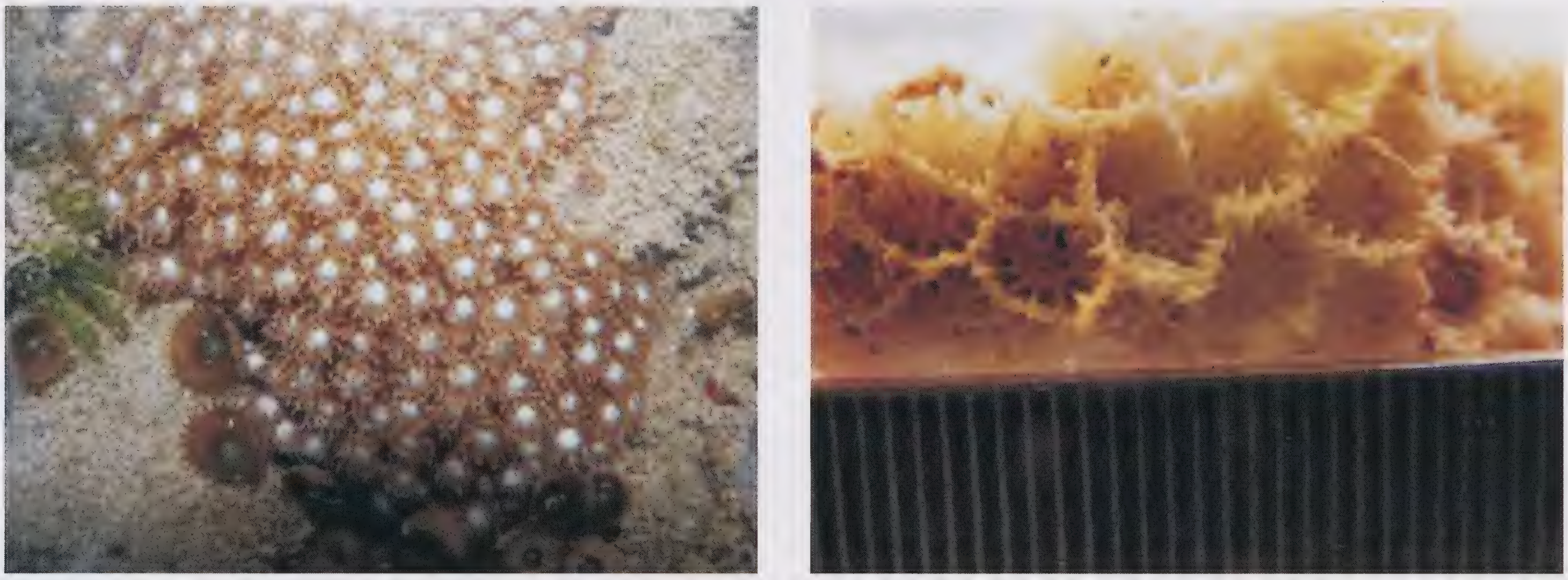
Genus: *Pseudosiderastrea* (Yabe and Sugiyama, 1935)

Specimen: *Pseudosiderastrea tayami* (Yabe and Sugiyama, 1935)

Taxonomic references: Veron and Pichon (1980), Coles (1996), Veron (2000), Venkatraman and Satyanarayana (2012).

IUCN Red List Category (2014): Near Threatened.

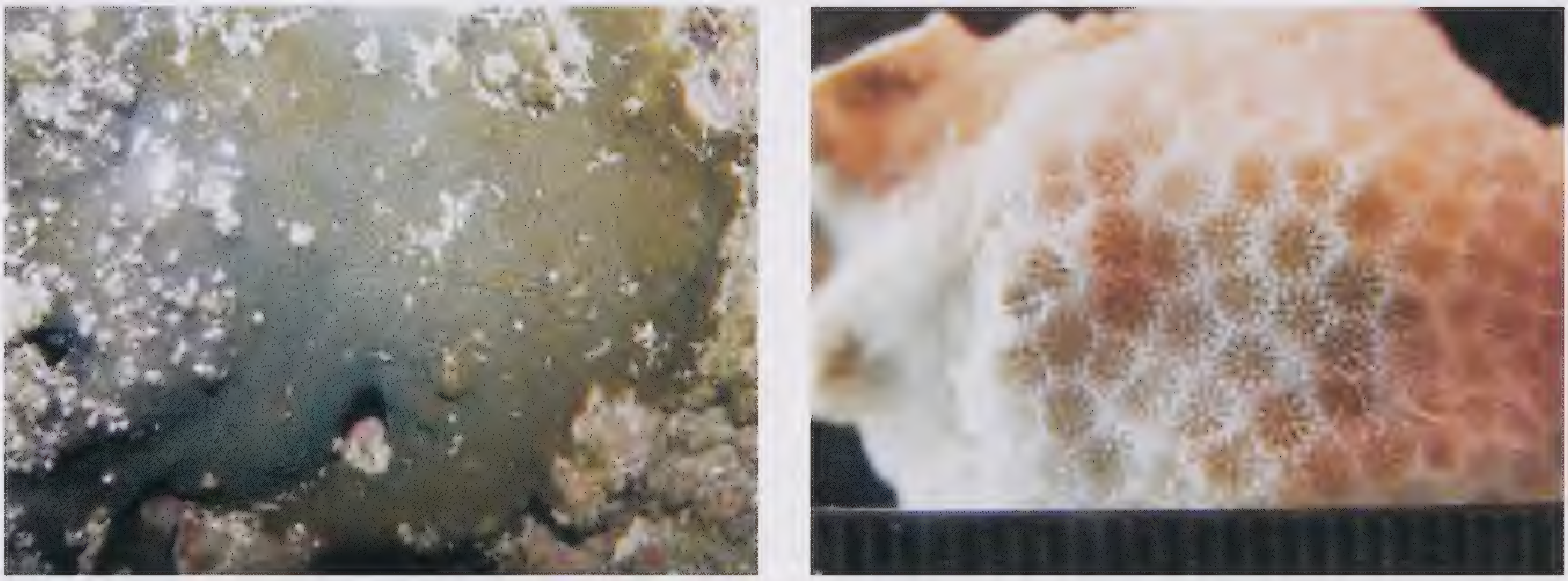
Description: Colonies are encrusting to slightly dome-shaped. Corallites are cerioid, polygonal and 3–6 mm in diameter. Septa are evenly spaced and usually fuse with each



Live colony

Corallites structure

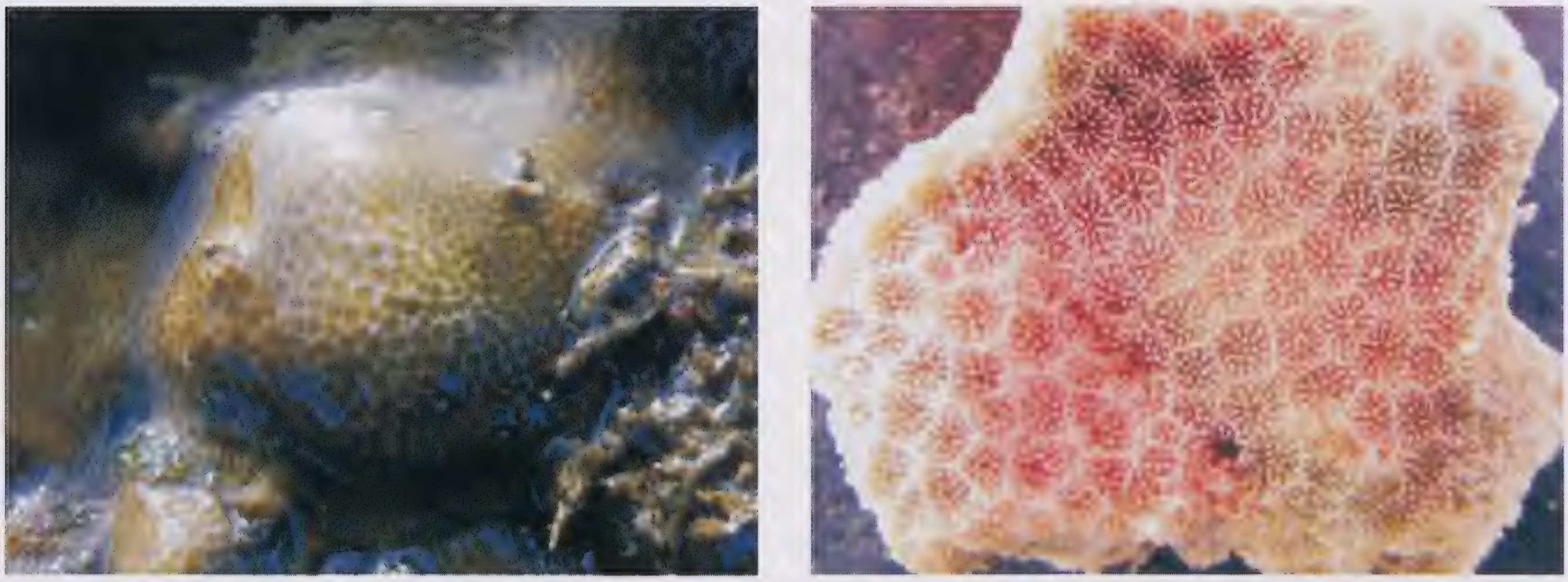
Fig. 1: *Goniopora columna*



Live colony

Corallites structure

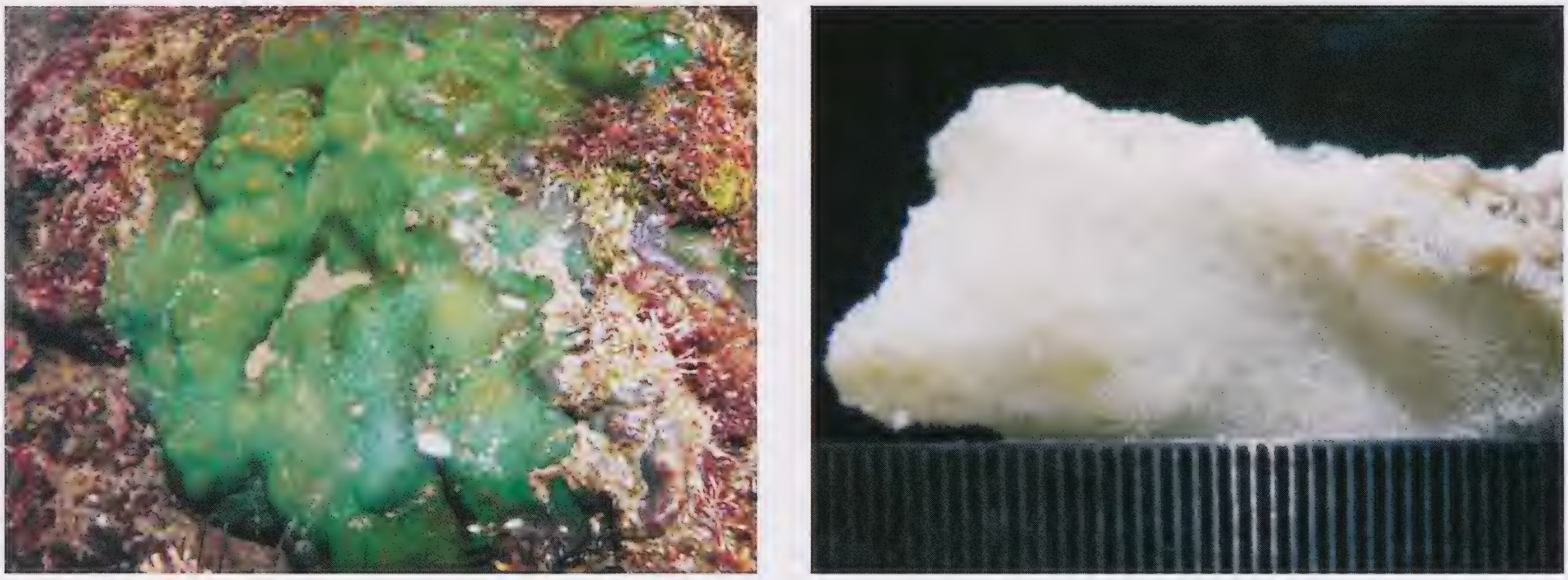
Fig. 2: *Porites lutea*



Live colony

Corallites structure

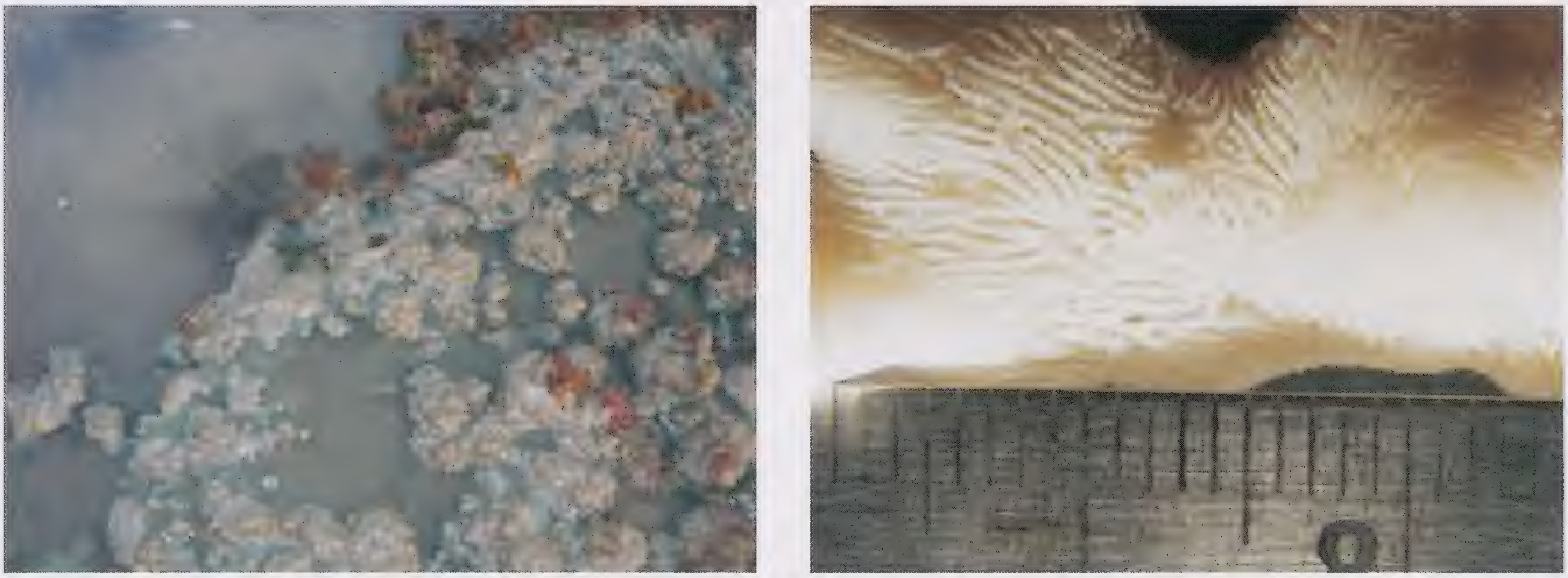
Fig. 3: *Porites stephensoni*



Live colony

Corallites structure

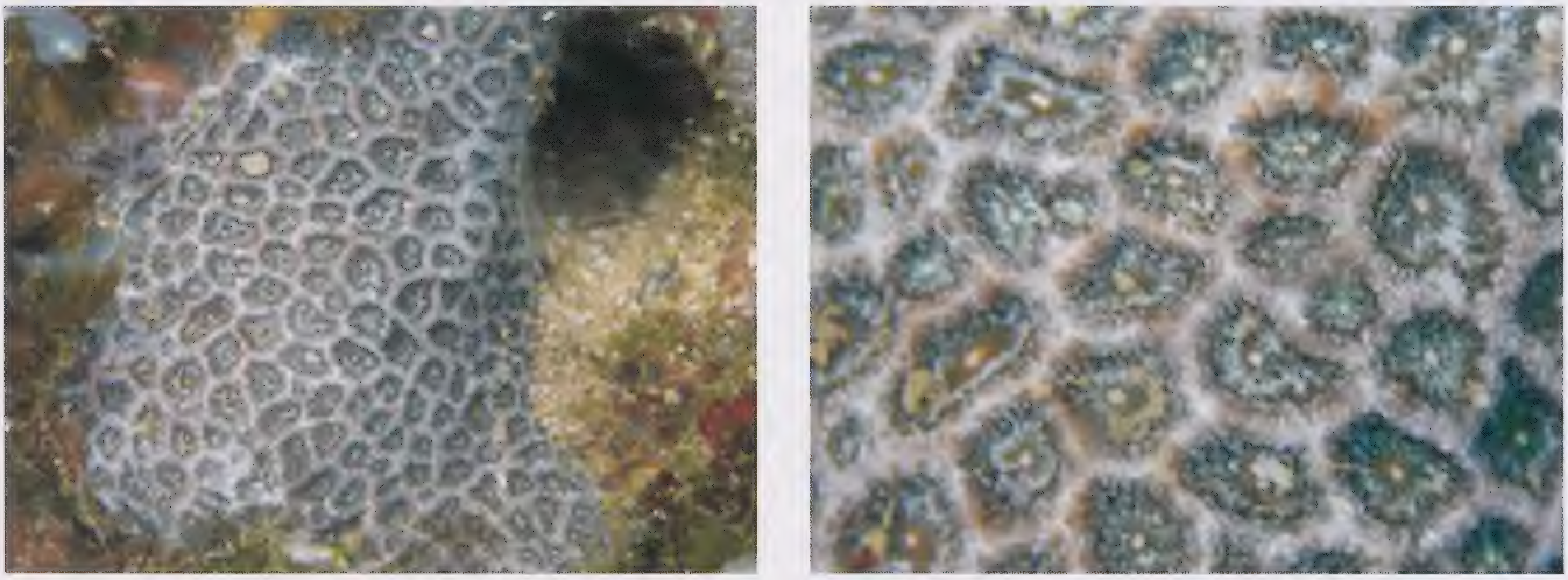
Fig. 4: *Psammocora superficialis*



Live colony

Corallites structure

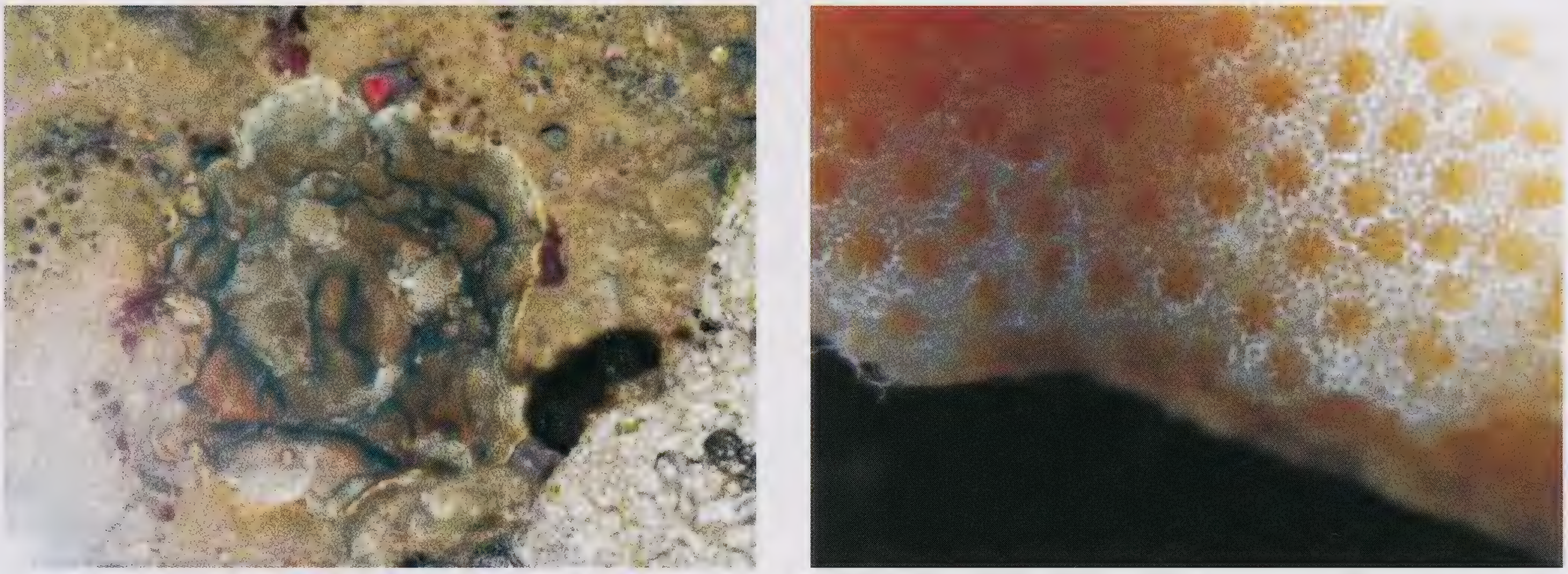
Fig. 5: *Psammocora vaughani*



Live colony

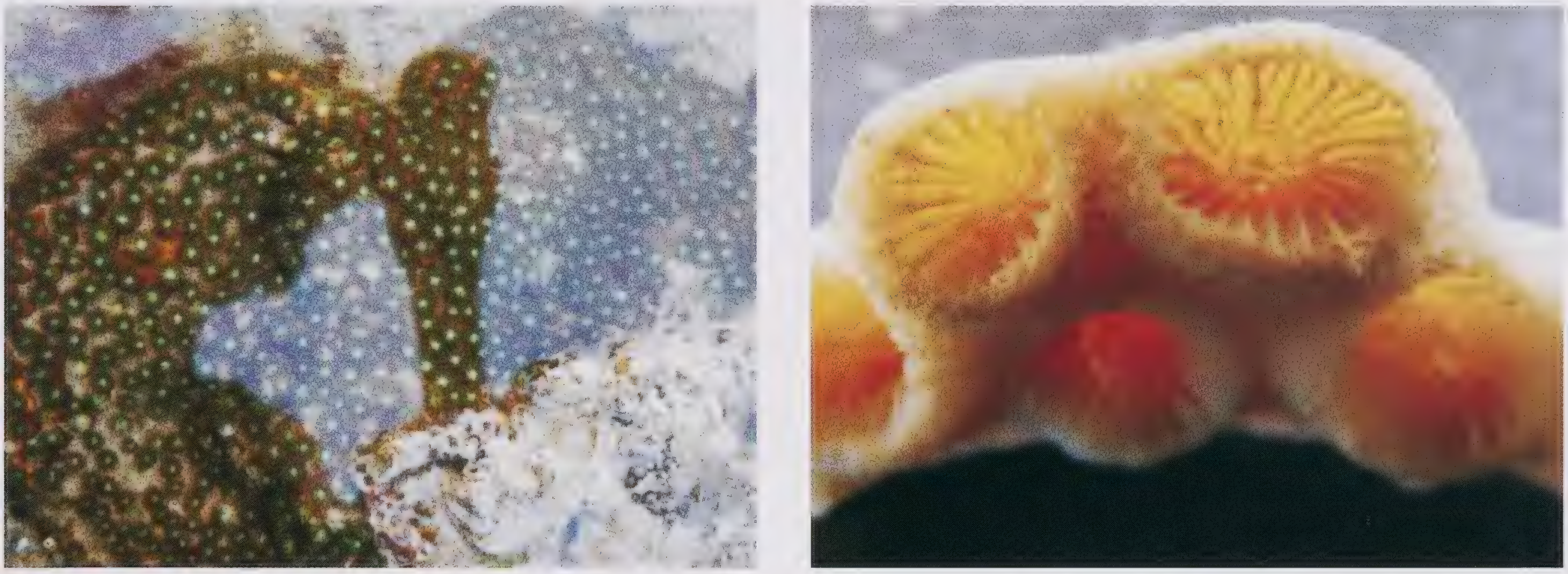
Corallites structure

Fig. 6: *Pseudosiderastrea tayami*



Live colony Corallites structure

Fig. 7: *Montipora venosa*



Live colony Corallites structure

Fig. 8: *Turbinaria peltata*

other in fan-like groups. Walls have a fine edge along the top. Uniform brown or light orange colour (Fig. 6).

Distribution: This species is found in the Red Sea and Gulf of Aden, southwest, northwest and north Indian Ocean, Arabian/Iranian Gulf, central Indo-Pacific, Australia, Southeast Asia, Japan and east China Sea, and west Pacific Ocean (IUCN 2014). This is a new record from the south Saurashtra coastline. It was previously reported from Gulf of Kachchh (Pillai 1983; Pillai and Patel 1988).

7. *Montipora venosa* (Ehrenberg, 1834)

Family: Acroporidae (Gray, 1847)
Genus: *Montipora* (de Blainville, 1830)
Specimen: *Montipora venosa* (Ehrenberg, 1834)

Taxonomic references: Veron and Wallace (1984), Veron (2000), Venkatraman and Satyanarayana (2012).

IUCN Red List Category (2014): Near Threatened.

Description: Colonies are massive or sub-massive and pale brown. Corallites are integrated, papillae are absent (Fig. 7).

Distribution: This species is found in the Red Sea, Gulf of Aden, southwest, northwest and northern Indian Ocean, Arabian/Iranian Gulf, central Indo-Pacific and west Pacific Ocean, north, west and eastern Australia, Southeast Asia, Japan and east China Sea (IUCN 2014). This species was previously reported from Gulf of Kachchh (Pillai 1983; Pillai and Patel 1988). However, it is a new record from the Saurashtra coastline.

8. *Turbinaria peltata* (Esper, 1794)

Family: Dendrophylliidae (Gray, 1847)
Genus: *Turbinaria* (Oken, 1815)
Specimen: *Turbinaria peltata* (Esper, 1794)

Synonym: *Turbinaria dichotoma* Verrill, 1871, *Turbinaria maxima* Ortmann, 1888

Taxonomic references: Veron and Pichon (1980), Veron (2000), Venkatraman and Satyanarayana (2012).

IUCN Red List Category (2014): Vulnerable.

Description: Colonies are encrusting or tubular, thickened with budding margins. Corallites project outward and average 6 mm diameter, calices circular. Polyps large, tentacles usually extended during the day (Fig. 8).

Distribution: This species is found in the Red Sea, Gulf of Aden, southwest, northwest and central Indian Ocean, Arabian/Iranian Gulf, central Indo-Pacific and west Pacific Ocean, Australia, southern Japan and South China Sea (IUCN 2014). It was reported from Gulf of Kachchh (Pillai 1983; Pillai and Patel 1988; Rashid 1985). However, this species is a new record from the Saurashtra coast.

In the present study, seven coral species were recorded from the intertidal zone of Diu, but the distributions of coral colonies were uneven in upper, middle, and lower zones. A single large colony of *Montipora venosa* from the middle littoral zone and another large colony of *Psammocora vaughani* from the lower littoral zone were recorded at Diu. Numerous small (15–45 cm diameter) to large (0.6–1.2 m diameter) colonies of *Goniopora columna* were distributed unevenly in all three littoral zones. Most of the large colonies of *Turbinaria peltata* were in the lower littoral zone; only one colony (0.5–0.6 m diameter) was recorded from the middle zone. Numerous small (5–20 cm diameter) colonies of *Porites lutea* and *P. stephensoni* were recorded from the upper and middle littoral zones. Small colonies (10–15 cm diameter) of *Pseudosiderastrea tayami* were also found unevenly distributed in the entire intertidal zone at Diu. On the other hand, at Veraval, large colonies of *Porites* species were seen even in the upper littoral zone, while small colonies were found in the middle and lower littoral zones. Formation of these coral species was found to be fairly widespread in this area compared to others. This may be due to the presence of small pools and puddles in the upper littoral zone even during the lowest tide. Small (0.3–0.6 m diameter) to large (0.9–1.5 m diameter) colonies of *Psammocora superficialis*, and tiny, newly established colonies (10–15 cm diameter) of *Pseudosiderastrea tayami* and *Goniopora columna* were recorded in middle and lower intertidal zones. At Mangrol coast, a few live colonies of *Porites lutea*, *P. stephensoni*, and *Pseudosiderastrea tayami* were recorded from the middle and lower littoral zones. The coastline exhibits abundant growth of seaweed which might have created unfavourable conditions for coral settlement. Widespread and small to large colonies of *Porites lutea* and *P. stephensoni* were evenly distributed in the entire littoral zone of Dwarka, and small colonies (10–15 cm diameter) of *Pseudosiderastrea tayami* and *Goniopora columna* were recorded in middle and lower intertidal zones. Small (0.3–0.6 m diameter) colonies of *Psammocora superficialis* were also recorded from middle and lower littoral zones of Mangrol. Almost all the colonies were of the encrusting type and the height of the colonies rarely exceeded 5 cm, except for *Montipora venosa* and some colonies of *Goniopora columna*.

DISCUSSION

In this report, eight scleractinian corals have been identified as new records from the intertidal zones of south Saurashtra, Gujarat. Out of the eight species recorded, seven are from reef building (hermatypic) group. The occurrence of the hermatypic corals along the western shores of India indicates that these corals are adapted to wider fluctuations in salinity and turbidity which they experience during the monsoon (Vaghela *et al.* 2010). The growth of coral requires uniform conditions of temperature, salinity, and turbidity. Along the Saurashtra coastline, the seawater temperature remains more or less uniform almost throughout the year. However, small variations in salinity are observed during monsoon (Bhadja and Kundu 2012). High level of turbidity was also observed in the monsoon and postmonsoon, possibly due to rainwater runoff during the south-west monsoon (Gohil *et al.* 2011; Misra and Kundu 2005). The occurrence of hermatypic corals in this intertidal zone is interesting because of their adaptation to changes in salinity and turbidity.

From the size of the colonies observed in this area, it is likely that the corals have been growing in these areas for quite some time, and would have experienced changes in environmental conditions. This indicates that although corals typically require uniform conditions, they can survive short spells of unfavourable changes in the environment.

All the surveyed locations where corals were recorded have luxurious growth of seaweeds. Strong wave action along the coast possibly prevents the growth of branching types of corals in this area. However, taking into account the slow growth rate of reef building corals and the size and height of the coral colonies, these colonies are probably not more than 3–4 years old. An interesting study would be about the possible origin of these coral colonies in this region. Since some of the genera recorded are also found in the Gulf of Kachchh, it is possible that planktonic plenula larvae might have drifted and settled in the intertidal region of south Saurashtra. However, the Gulf of Kachchh is too far to be the possible source of these corals. The possibility of live coral colonies in the subtidal regions as a source from where coral larvae might be migrating and colonizing the intertidal zones needs examination.

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NEW RECORDS OF SEAWEEDS FROM THE GOA COAST, INDIA

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A seasonal study on the occurrence of marine algae was conducted during 2008–2010 along 17 stations on the Goa Coast. About 39 species have been reported for the first time, thereby forming new records for the Coast of Goa. This paper gives a preliminary report of these species. An attempt to list the algae along with its taxonomic descriptions and ecological notes has been made here.

Key words: Seaweeds, Goa Coast, new records, seasonal growth

INTRODUCTION

Goa is situated along the West Coast of India (14° 49' – 15° 52' N; 73° 38' – 74° 24' E), with a short coastline of about 120 km. It is segmented by estuaries, beaches, rocky shores, cliffs, bays, and creeks. There are seven estuaries, three bays, and 28 sandy as well as rocky beaches. The seaweeds along the Goa coast have been studied extensively by Agadi and Untawale (1978), Dhargalkar *et al.* (1981), Untawale and Dhargalkar (1986), Agadi (1986), and Dhargalkar (1981, 2008). One of the early records of seaweeds along the Goa coast enumerated about 50 species (Agadi and Untawale 1978), followed by 81 species recorded by Dhargalkar (1981). Later, Agadi (1986) documented 77 species along the Goa coast. The present study reports a larger number of algae than previous studies, and agrees with Dhargalkar (1981) and Agadi's (1986) findings in ranking Rhodophyta as the group with the highest number of species. In all, 154 species of seaweeds belonging to Cyanophyta, Rhodophyta, Xanthophyta, Phaeophyta, and Chlorophyta were obtained in this study (Table 1). Of these, 39 species have not been reported earlier from the Goa coast, though their presence has been documented along different parts of the Indian coast. Hence, they are new records for the Goa region.

The growth of seaweeds is governed by environmental factors, which are in turn influenced by different seasons (Dhargalkar 1981). It was observed that algae show maximum growth during winter. The nature of the substratum is an important factor for seaweed growth. Stations having lateritic rocks exhibited maximum growth of algae. Earlier studies of seaweeds conducted along the Goa coast by Dhargalkar (1981) and Agadi (1986) were restricted to 12 and 5 stations respectively. In order to obtain a comprehensive idea about the seaweed distribution along the Goa coast, more stations were added to the study area. In the present investigation, 17 stations were chosen to study seaweed distribution. Thus, more seaweed species were found.

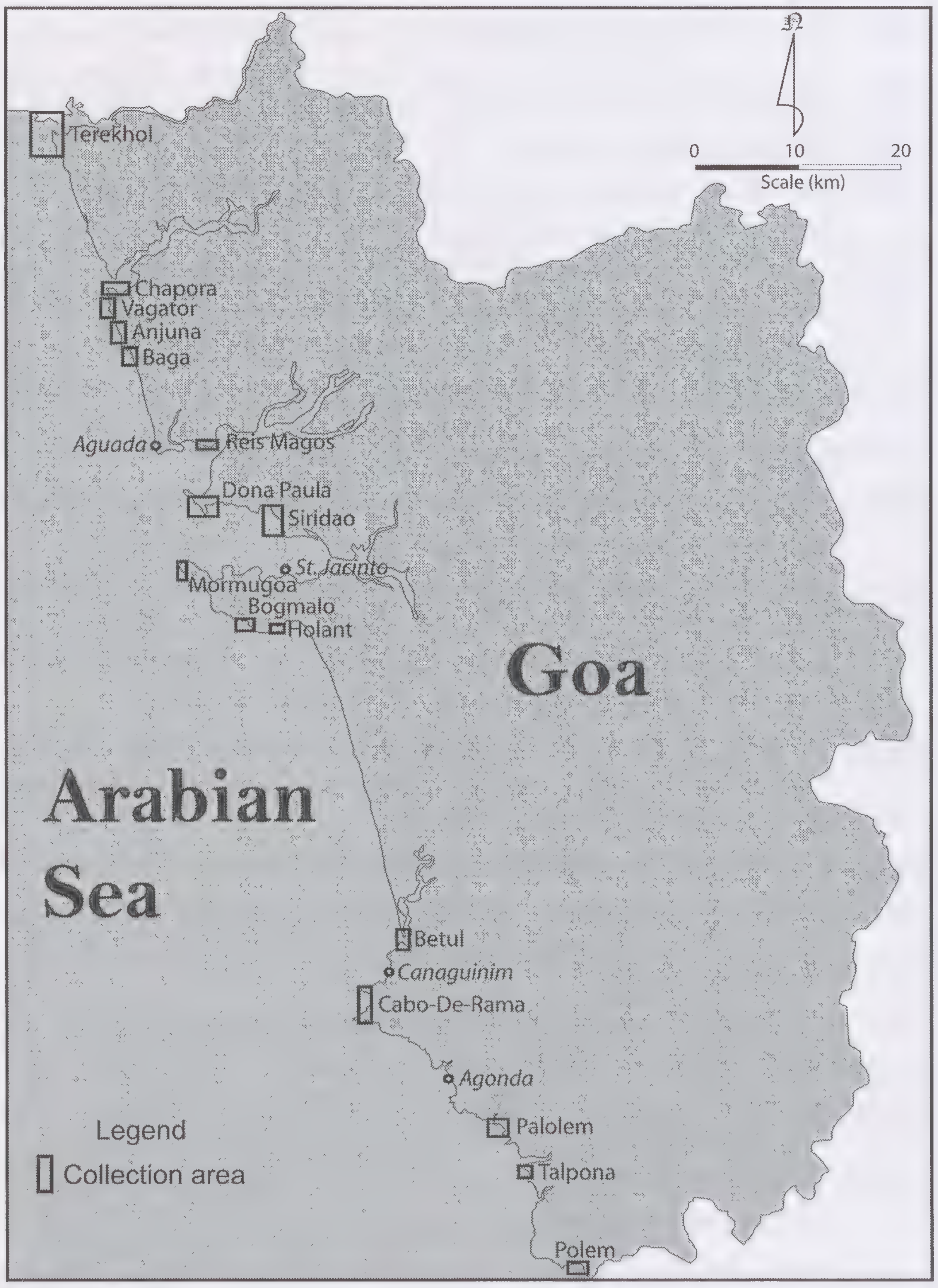

Fig. 1: Stations surveyed along the Goa coast

METHODOLOGY

The study area comprised 17 stations spanning the entire coast of Goa. Terekhol, Chapora, Vagator, Anjuna, Baga, Reis Magos, Dona Paula, and Siridao in northern Goa, and Mormugao, Bogmalo, Holant, Betul, Cabo-de-Rama, Palolem, Talpona, and Polem in southern Goa were chosen for seaweed collection and seasonal studies (Fig. 1). In view of its ecological importance, Chicalim Bay, was surveyed once. Beaches with rocky shores were chosen for surveys, as rocks form a suitable substratum for seaweeds (Srinivasan 1969). Seaweed collection done in different seasons helps in determining variation in algal growth (Chennubothla *et al.* 1987). Seaweeds were therefore collected during three seasons: Pre-monsoon (March–June), Monsoon (July–September), and Post-monsoon (October–February), between October 2008 and September 2010, from the study area. A stratified random sampling method was followed to collect the seaweeds (Coppejans *et al.* 2009). Specimens collected were preserved in the form of herbarium and also in 4% seawater-formalin solution. The specimens were then identified following Taylor (1960), Lawson and John (1982), and Tseng (1983), followed by more recent literature (Barbara 2009; Coppejans *et al.* 2009; Jha *et al.* 2009).

Table 1: Seaweeds of the Goa coast

Sr. No.	Species	Herbarium Voucher/ Sample No.
1	*Chroococcus turgidus* (Kützing) Nageli	MAEC/Goa/Cya/Sp.Jar 1
2	*Lyngbya majuscula* Harvey ex Gomont	MAEC/Goa/Cya/001
3	*Oscillatoria nigroviridis* Thwaites ex Gomont	MAEC/Goa/Cya/Sp.Jar 2
4	*Leptolyngbya fragilis* (Gom.) Anagnostidis & Komárek	MAEC/Goa/Cya/Sp.Jar 3
5	*Microcoleus chthonoplastes* Thuret ex Gomont	MAEC/Goa/Cya/002
6	*Sirocoleum kurzii* Gomont	MAEC/Goa/Cya/Sp.Jar 4
7	*Trichormus variabilis* (Kützing ex Bornet & Flahault) Komárek & Anagnostidis	MAEC/Goa/Cya/Sp.Jar 1
8	*Scytonema rivulare* Borzì ex Bornet & Flahault	MAEC/Goa/Cya/Sp.Jar 5
9	*Erythrocladia irregularis* Rosenvinge	MAEC/Goa/Rho/Sp.Jar 6
10	*Porphyra crispata* Kjellman	MAEC/Goa/Rho/003
11	*Pyropia suborbiculata* (Kjellman) Sutherland, Choi, Hwang & Nelson	MAEC/Goa/Rho/004
12	*Porphyra vietnamensis* T. Tanaka & Pham-Hoàng Ho	MAEC/Goa/Rho/005
13	*Acrochaetium robustum* Børgesen	MAEC/Goa/Rho/Sp.Jar 7
14	*Ahnfeltia plicata* (Hudson) Fries	MAEC/Goa/Rho/006
15	*Gelidium micropterum* Kützing	MAEC/Goa/Rho/007
16	*Gelidium pusillum* (Stack.) Jolis	MAEC/Goa/Rho/008
17	*Pterocladia capillacea* (Gmelin) Bornet	MAEC/Goa/Rho/009
18	*Gracilaria corticata* (J. Ag.) J. Ag.	MAEC/Goa/Rho/010
19	*Gracilaria foliifera* (Forsskål) Børges.	MAEC/Goa/Rho/011
20	*Gracilaria verrucosa* (Huds.) Papenf.	MAEC/Goa/Rho/012
21	*Grateloupia filicina* (Lamour.) C. Ag.	MAEC/Goa/Rho013
22	*Grateloupia filicina* (Lamour.) C. Ag. f. *horrida* (Kutz.) Børges.	MAEC/Goa/Rho/014
23	*Grateloupia lithophila* Børges.	MAEC/Goa/Rho/015
24	*Peyssonnelia obscura* Bosse var. *bombayensis* Børges.	MAEC/Goa/Rho/Sample 1
25	*Hildenbrandia rubra* (Sommerfelt) Menegh.	MAEC/Goa/Rho
26	*Amphiroa anceps* (Lamarck) Decaisne	MAEC/Goa/Rho/016
27	*Amphiroa fragilissima* (L.) Lamour.	MAEC/Goa/Rho/017
28	*Amphiroa rigida* Lamour.	MAEC/Goa/Rho/018
29	*Cheilosporum spectabile* Harvey ex Grunow	MAEC/Goa/Rho/019
30	*Corallina officinalis* L.	MAEC/Goa/Rho/020
31	*Hydrolithon farinosum* (Lamour) Penrose & Chamber.	MAEC/Goa/Rho/021
32	*Hydrolithon reinboldii* (Bosse & Foslie) Foslie	MAEC/Goa/Rho/Sample 2

Table 1: Seaweeds of the Goa coast (*contd.*)

Sr. No.	Species	Herbarium Voucher/ Sample No.
33	*Jania rubens* (L.) Lamour.	MAEC/Goa/Rho/022
34	*Lithophyllum orbiculatum* (Foslie) Foslie	MAEC/Goa/Rho/Sample 3
35	*Mesophyllum erubescens* (Foslie) Lemoine	MAEC/Goa/Rho/Sample 4
36	*Catenella caespitosa* (Withering) L.Irvine	MAEC/Goa/Rho/Sp.Jar 1
37	*Chondracanthus acicularis* (Roth) Fredericq	MAEC/Goa/Rho/023
38	*Hypnea flagelliformis* Greville ex J. Ag.	MAEC/Goa/Rho/024
39	*Hypnea musciformis* (Wulfen) Lamour.	MAEC/Goa/Rho/025
40	*Hypnea spinella* (C.Ag.) Kütz.	MAEC/Goa/Rho/026
41	*Hypnea valentiae* (Turner) Mont.	MAEC/Goa/Rho/027
42	*Ahnfeltiopsis pygmaea* (J. Ag.) P. Silva & DeCew	MAEC/Goa/Rho/028
43	*Champia compressa* Harvey	MAEC/Goa/Rho/029
44	*Champia parvula* (C. Ag.) Harvey	MAEC/Goa/Rho/Sp.Jar 6
45	*Gastroclonium compressum* (Hollen.) Chang & B.Xia	MAEC/Goa/Rho/Sp.Jar 7
46	*Gelidiopsis variabilis* (Greville ex J. Agardh) Schmitz	MAEC/Goa/Rho/030
47	*Antithamnion cruciatum* (C. Ag.) Nageli	MAEC/Goa/Rho/Sp.Jar 7
48	*Centroceras clavulatum* (C. Ag.) Montagne	MAEC/Goa/Rho/Sp.Jar 8
49	*Ceramium cimbricum* H. Petersen	MAEC/Goa/Rho/031
50	*Ceramium cruciatum* Collins & Hervey	MAEC/Goa/Rho/Sp.Jar 9
51	*Gayliella flaccida* (Harv. ex Kutz.) Cho & McIvor	MAEC/Goa/Rho/Sp.Jar 10
52	*Aglaothamnion tenuissimum* (Bonnemaison) Feldmann-Mazoyer	MAEC/Goa/Rho/032
53	*Crouania attenuata* (C. Ag.) J. Ag.	MAEC/Goa/Rho/Sp.Jar 11
54	*Ptilothamnion speluncarum* (Coll. & Herv.) Ballan. & Wynne	MAEC/Goa/Rho/Sp.Jar 12
55	*Wrangelia argus* (Montagne) Montagne	MAEC/Goa/Rho/033
56	*Dasya ocellata* (Grateloup) Harvey	MAEC/Goa/Rho/Sp.Jar 13
57	*Caloglossa leprieurii* (Montagne) G. Martens	MAEC/Goa/Rho/034
58	*Caloglossa ogasawaraensis* Okamura	MAEC/Goa/Rho/Sp.Jar 14
59	*Erythroglossum lusitanicum* Ardré	MAEC/Goa/Rho/035
60	*Hypoglossum hypoglossoides* (Stack.) Collins & Hervey	MAEC/Goa/Rho/Sp.Jar 15
61	*Martensia fragilis* Harvey	MAEC/Goa/Rho/036
62	*Acanthophora muscoides* (L.) Bory	MAEC/Goa/Rho/037
63	*Acanthophora spicifera* (Vahl) Børges.	MAEC/Goa/Rho/038
64	*Bostrychia radicans* (Montagne) Montagne	MAEC/Goa/Rho/039
65	*Bostrychia tenella* (Lamour.) J. Ag.	MAEC/Goa/Rho/040
66	*Chondria armata* (Kütz.) Okamura	MAEC/Goa/Rho/041
67	*Chondria capillaris* (Hudson) Wynne	MAEC/Goa/Rho/042
68	*Herposiphonia secunda* (C. Ag.) Am. f. *tenella* (C. Ag.) Wynne	MAEC/Goa/Rho/Sp.Jar 16
69	*Laurencia obtusa* (Hudson) Lamour.	MAEC/Goa/Rho/Sp.Jar 17
70	*Neosiphonia ferulacea* (Suhr ex. J. Ag.) Guim. & Fujii	MAEC/Goa/Rho/Sp.Jar 18
71	*Polysiphonia atlantica* Kapraun & Norris	MAEC/Goa/Rho/Sp.Jar 19
72	*Polysiphonia denudata* (Dillwyn) Greville ex Harvey	MAEC/Goa/Rho/Sp.Jar 20
73	*Vaucheria longicaulis* Hoppaugh	MAEC/Goa/Rho/Sp.Jar 21

Table 1: Seaweeds of the Goa coast (*contd.*)

Sr. No.	Species	Herbarium Voucher/ Sample No.
74	*Feldmannia indica* (Sonder) Womersley & Bailey	MAEC/Goa/Rho/Sp.Jar 22
75	*Feldmannia irregularis* (Kütz.) Hamel	MAEC/Goa/Rho/Sp.Jar 23
76	*Hincksia mitchellae* (Harvey) Silva	MAEC/Goa/Rho/Sp.Jar 24
77	*Ralfsia verrucosa* (Aresch.) Aresch.	MAEC/Goa/Pha
78	*Sphacelaria furcigera* Kütz.	MAEC/Goa/Pha/043
79	*Canistrocarpus cervicornis* (Kutz.) Paula et Clerck	MAEC/Goa/Pha/044
80	*Canistrocarpus crispatus* (Lamour.) Paula et Clerck	MAEC/Goa/Pha/045
81	*Canistrocarpus magneanus* (Clerck et Coppejans) Paula et Clerck	MAEC/Goa/Pha/046
82	*Dictyopteris australis* (Sonders) Askenasy	MAEC/Goa/Pha/047
83	*Dictyota bartayresiana* Lamour.	MAEC/Goa/Pha/048
84	*Dictyota ceylanica* Kütz.	MAEC/Goa/Pha/049
85	*Dictyota ciliolata* Sonder ex Kützing	MAEC/Goa/Pha/050
86	*Dictyota dichotoma* (Huds.) Lamour.	MAEC/Goa/Pha/051
87	*Dictyota divaricata* Lamour.	MAEC/Goa/Pha/052
88	*Dictyota dumosa* Børges.	MAEC/Goa/Pha/053
89	*Padina antillarum* (Kütz.) Piccone	MAEC/Goa/Pha/054
90	*Padina australis* Hauck	MAEC/Goa/Pha/055
91	*Padina boryana* Thivy	MAEC/Goa/Pha/056
92	*Padina gymnospora* (Kütz.) Sond.	MAEC/Goa/Pha/057
93	*Padina pavonica* (L.) Thivy	MAEC/Goa/Pha/058
94	*Spatoglossum asperum* J. Ag.	MAEC/Goa/Pha/059
95	*Spatoglossum variabile* Figari & De Notaris	MAEC/Goa/Pha/060
96	*Stoechospermum polypodioides* (Lamour.) J. Ag.	MAEC/Goa/Pha/061
97	*Chnoospora minima* (Hering) Papenf.	MAEC/Goa/Pha/062
98	*Colpomenia sinuosa* (Mert. ex Roth) Derbes et Solier	MAEC/Goa/Pha/063
99	*Iyengaria stellata* (Børges.) Børges.	MAEC/Goa/Pha/064
100	*Rosenvingea orientalis* (J. Ag.) Børges.	MAEC/Goa/Pha/065
101	*Sargassum cinctum* J. Ag.	MAEC/Goa/Pha/066
102	*Sargassum cinereum* J. Ag.	MAEC/Goa/Pha/067
103	*Sargassum cinereum* J. Ag. var. *berberifolium* Børges.	MAEC/Goa/Pha/068
104	*Sargassum crassifolium* J. Ag.	MAEC/Goa/Pha/069
105	*Sargassum glaucescens* J. Ag.	MAEC/Goa/Pha/070
106	*Sargassum ilicifolium* (Turner) C. Ag.	MAEC/Goa/Pha/071
107	*Sargassum plagiophyllum* C. Ag.	MAEC/Goa/Pha/072
108	*Sargassum polycystum* C. Ag.	MAEC/Goa/Pha/073
109	*Sargassum prismaticum* Chauhan	MAEC/Goa/Pha/074
110	*Sargassum swartzii* C. Ag.	MAEC/Goa/Pha/075
111	*Sargassum tenerrimum* J. Ag.	MAEC/Goa/Pha/076
112	*Sargassum vulgare* C. Ag.	MAEC/Goa/Pha/077
113	*Gayralia oxysperma* (Kütz.) Vinogradova ex Scagel	MAEC/Goa/Chl/078
114	*Ulva clathrata* (Roth) C. Ag.	MAEC/Goa/Chl/079

Table 1: Seaweeds of the Goa coast (*contd.*)

Sr. No.	Species	Herbarium Voucher/ Sample No.
115	*Ulva compressa* L.	MAEC/Goa/Chl/080
116	*Ulva conglobata* Kjellman	MAEC/Goa/Chl/081
117	*Ulva flexuosa* Wulfen	MAEC/Goa/Chl/082
118	*Ulva intestinalis* L.	MAEC/Goa/Chl/083
119	*Ulva lactuca* L.	MAEC/Goa/Chl/084
120	*Ulva rigida* C. Ag.	MAEC/Goa/Chl/085
121	*Ulva taeniata* (Setch.) Setch. et Gardn.	MAEC/Goa/Chl/086
122	*Chaetomorpha antennina* (Bory) Kütz.	MAEC/Goa/Chl/087
123	*Chaetomorpha linum* (Müller) Kütz.	MAEC/Goa/Chl/088
124	*Chaetomorpha spiralis* Okam.	MAEC/Goa/Chl/Sp.Jar 25
125	*Cladophora bombayensis* Børges.	MAEC/Goa/Chl/Sp.Jar 26
126	*Cladophora coelothrix* Kütz.	MAEC/Goa/Chl/Sp.Jar 27
127	*Cladophora glomerata* (L.) Kütz.	MAEC/Goa/Chl/Sp.Jar 28
128	*Cladophora herpestica* (Mont.) Kütz.	MAEC/Goa/Chl/089
129	*Cladophora lehmanniana* (Lindenberg) Kütz.	MAEC/Goa/Chl/Sp.Jar 29
130	*Cladophora prehendens* Kraft & Millar	MAEC/Goa/Chl/Sp.Jar 30
131	*Cladophora prolifera* (Roth) Kütz.	MAEC/Goa/Chl/090
132	*Cladophora rhizocloniodea* Hoek & Womersley	MAEC/Goa/Chl/091
133	*Cladophora saracenica* Børges.	MAEC/Goa/Chl/Sp.Jar 31
134	*Cladophora socialis* Kütz.	MAEC/Goa/Chl/092
135	*Cladophora vagabunda* (L.) Hoek	MAEC/Goa/Chl/093
136	*Rhizoclonium riparium* (Roth) Harv.	MAEC/Goa/Chl/094
137	*Rhizoclonium tortuosum* (Dill.) Kütz.	MAEC/Goa/Chl/095
138	*Boodlea composita* (Harvey) Brand	MAEC/Goa/Chl/Sp.Jar 32
139	*Cladophoropsis sundanensis* Reinbold	MAEC/Goa/Chl/096
140	*Phyllodictyon anastomosans* (Harvey) Kraft & Wynne	MAEC/Goa/Chl/097
141	*Valoniopsis pachynema* (Martens) Børges.	MAEC/Goa/Chl/098
142	*Bryopsis hypnoides* Lamour.	MAEC/Goa/Chl/099
143	*Bryopsis pennata* Lamour.	MAEC/Goa/Chl/100
144	*Bryopsis plumosa* (Hudson) C. Ag.	MAEC/Goa/Chl/101
145	*Caulerpa peltata* Lamour.	MAEC/Goa/Chl/102
146	*Caulerpa racemosa* (Forsskål) J. Ag.	MAEC/Goa/Chl/103
147	*Caulerpa scalpelliformis* (Brown ex Turner) C. Ag.	MAEC/Goa/Chl/104
148	*Caulerpa sertularioides* (Gmelin) Howe	MAEC/Goa/Chl/105
149	*Caulerpa sertularioides* f. *brevipes* (J. Ag.) Svedelius	MAEC/Goa/Chl/106
150	*Caulerpa sertularioides* f. *longiseta* (Bory) Sved.	MAEC/Goa/Chl/107
151	*Caulerpa verticillata* J. Ag.	MAEC/Goa/Chl/108
152	*Avrainvillea erecta* (Berkeley) A. Gepp & E. Gepp	MAEC/Goa/Chl/109
153	*Boodleopsis pusilla* (Coll.)Taylor, Joly & Bernatowicz	MAEC/Goa/Chl/Sp.Jar 33
154	*Chlorodesmis hildebrandtii* A. Gepp & E. Gepp	MAEC/Goa/Chl/Sp.Jar 34

RESULTS

In all, 154 species were identified, of which 39 species were found to be new to the Goa coast, including 19 rhodophytes, 1 xanthophyte, 6 phaeophytes, and 13 chlorophytes. Several species mentioned here have been reported from different parts of India along the east and west coasts (Sahoo *et al.* 2001). Though some species such as *Cladophora herpestica*, *Cladophoropsis sundanensis*, and others were found to occur in the neighbouring Konkan region, they were not reported from Goa and hence form new records. This study resulted in the preparation of 24 herbarium specimens, 12 samples preserved in formalin and 3 specimens as dry forms (Table 2). All the specimens are deposited at the Magdelin Almeida Environmental Centre (MAEC) at Sawantwadi.

Species account

1. ***Porphyra crispata*** Kjellman, Bih. Kongl. Svenska Vetensk.-Akad. Handl. 23 (Afd. III, 4: 15, t. 1, f. 4, 5; t. 3, f. 5–7; t. 5, f. 15, 1897; Anil Kumar *et al.* Seaweed Res. Util. 17(1&2): 37–50, 1995.

Phyllona crispata (Kjellman) Kuntze, Rev. Gen. t. 3(3): 420, 1898.

Type locality: Goto-retto, Nagasaki Prefecture, Japan (*fide* Silva 2012).

Diagnosis: Thalli membranous, light purple to greenish hued, monostromatic, ovate or reniform, caespitose, often laciniated, 2–5 cm tall, 2–4 cm broad with dentate edge, basal part cordate or umbilicate. Vegetative cells with stellate chromatophore. Monoecious plant with both spermatangial and carposporangial regions on the same margin.

Material examined: Two specimens.

Season: Monsoon.

Habitat: Intertidal rock surface.

Distribution: Bogmalo.

Remark: According to algaebase.org, this species could be referred as a taxonomic synonym of *Monostroma nitidum* Wittrock.

2. ***Pyropia suborbiculata*** (Kjellman) J.E. Sutherland, H.G. Choi, M.S. Hwang & W.A. Nelson, J. Phycol. 47(5): 1131–1151, 2011.

Porphyra suborbiculata Kjellman 1897 Bih. Kongl. Svenska Vetensk.-Akad. Handl. 23 (Afd. III, 4): 10, pl. 1: figs. 1–3; pl. 2: figs. 5–9; pl. V: figs. 4–7, 1897. Anil Kumar *et al.*, Seaweed Res. Util. 17(1&2): 37–50, 1995; Sahoo *et al.*, Seaweeds of the Indian Coast 283, 2001.

Type locality: Goto-retto, Nagasaki, Japan (*fide* Silva 2012).

Diagnosis: Plants membranous, gregarious, greenish purple; attached by small rhizoids; blade monostromatic, ovate to reniform, 3–4 cm in diameter; margin undulate, with small, spinulose processes which are not in the same plane as the blade; presence of a minute basal stipe. Cells in surface view angular with rounded corners, isodiametric in transverse section, 28–35 µm in diameter, slightly higher than broad, containing a stellate plast with central pyrenoid. Plants monoecious, sori of deep red carpogonia and yellowish spermatangia in irregular patches (sori) arranged along the margin of the frond.

Material examined: Two specimens.

Season: Monsoon.

Habitat: Epilithic in the supralittoral fringe of rock outcrops exposed to extreme surf; only present in the wet season.

Distribution: Palolem.

3. ***Gelidium micropterum*** Kützing, Tab. Phycol. 21, t. 59: f. c–g, 1868; Børgesen, J. Indian Bot. Soc. 17: 205–242, t. 7. f. 3, 1938; Untawale *et al.* Indian J. Mar. Sci. 18: 73–81, t. 2, f. 3, 1989; Jha *et al.* Diversity Distr. Seaweeds Guj. Coast 215, 2009.

Type locality: South Africa: Cape of Good Hope (*fide* Silva 2012).

Diagnosis: Plants dark red in colour, 5 cm tall, growing as tufts or patches, cartilaginous, flattened, 0.2–0.5 mm broad with blunt apices, branching bi- to tri-pinnate or sometimes irregular, tetrasporangia confined to short swollen fertile tips, cystocarps swollen and sub-spherical, giving the branches a roundish appearance.

Material examined: Four specimens.

Season: Post-monsoon.

Habitat: Found horizontally on rocks at low water level of the coast.

Distribution: Chapora, Baga, Reis Magos, Talpona.

4. ***Peyssonnelia obscura*** Weber-van Bosse var. ***bombayensis*** Børgesen, Biol. Meddel. Kongel. Danske Vidensk. Selsk. 12(2): 44–47, f. 18, 19, 1935; Umamaheshwara Rao & Sreeramulu, Bot. J. Linn. Soc. 63: 23–45, f. 65, 1970; Jha *et al.* Diversity Distr. Seaweeds Guj. Coast 215, 2009.

Type locality: Malabar Hill, Bombay (now Mumbai), India (*fide* Børgesen 1935).

Diagnosis: Thalli deep rose red on the upper surface and smooth, crustose, orbicular, growing on old subtidal coral fragments. The crust 1–3 cm broad adheres by numerous short, unicellular rhizoids given out from hypothallium. In transverse section, the central part is about 4 cells thick, hypothallium composed of one layer of rectangular cells.

Material examined: Two specimens.

Season: Post-monsoon.

Habitat: Occurs in the lower eulittoral zone.

Distribution: Talpona.

Remark: According to algaebase.org, this species is currently considered as a taxonomic synonym of *Peyssonnelia obscura* Weber-van Bosse.

5. ***Amphiroa rigida*** Lamouroux, Histoire des polypiers coralligènes flexibles, vulgairement nommés zoophytes: 297, t. 11, f. 1, 1816; Untawale & Jagtap, Aquatic Botany 19: 97–103, t. 1, f. 3, 1984; Jagtap, *In*: Marine Plants (Eds: Krishnamurty, V. & A.G. Untawale), 43–50. t. 1, f. 4, 1985.

Type locality: Mediterranean Sea (*fide* Silva *et al.* 1996).

Diagnosis: Plants about 2–10 cm tall, bushy, chalky-pink to purplish-pink, composed of erect axes that are complanate, di- to trichotomously branched; attached by a crustose holdfast; branch apices rounded to blunt; intergenicula cylindrical to compressed, fairly uniform in width, sometimes tapering slightly basally, rectangular in shape, 2–8 mm long, 0.5–2 mm in diameter, with surfaces covered in wart-like reproductive capsules. Reproductive structures borne in hemispherical conceptacles on the surface of intergenicula.

Material examined: Four specimens.

Season: Post-monsoon.

Habitat: Epilithic, rarely epiphytic, mostly in the subtidal, occurring to 34 m depth but also found in intertidal rock pools.

Distribution: Cabo-de-Rama, Palolem.

6. ***Hydrolithon farinosum*** (Lamouroux) Penrose & Chamberlain, Phycologia 32: 295, 302, 1993; Sahoo *et al.* Seaweeds of the Indian Coast 283, 2001.

Melobesia farinosa Lamouroux, Hist. Polyp.: 315, t. 12, f. 3, 1816; Balakrishnan, J. Ind. Bot. Soc., 47: 305–319, 1946; Krishnamurthy & Joshi, A Checklist of Marine Algae, 36, 1970.

Fosliella farinosa (Lamouroux) Howe, The Bahama flora: 587, 1920; Umamaheshwara Rao & Sreeramulu, Bot. J. Linn. Soc. 63: 23–45, f. 65, 1970; Untawale *et al.,* List of marine algae from India 42, f. 36, 1983.

Type locality: Mediterranean Sea (*fide* Chamberlain 1983).

Diagnosis: Plants generally forming small, circular disks about 5 mm to 10 mm in width, 1 cell thick in sterile plants and 3 cells thick in fruiting portions, showing radiating rows of cells and frequently colourless, slightly elongated heterocyst cells; sporangial and cystocarpic conceptacles 140 to 250 µm in diameter.

Material examined: Five specimens.

Season: Post-monsoon.

Habitat: Occurs as pink spots on the surface of larger brown algae in the eulittoral zone up to a depth of 15 m.

Distribution: Talpona.

7. ***Hydrolithon reinboldii*** (Weber-van Bosse & Foslie) Foslie, K. Norske Vid. Selsk. Skr. 1909(2): 55, 1909; Desikachary & Ganesan, Phykos, 5: 83–90, f.13, 1967; Krishnamurthy & Jayagopal, Seaweed Res. Util., 10: 81–96, f. 30, 1987; Sahoo *et al.* Seaweeds of the Indian Coast 283, 2001.

Lithophyllum reinboldii Weber-van Bosse & Foslie in Foslie, K. Norske Vid. Selsk. Skr. 1901(1): 5, 1901.

Goniolithon reinboldii (Weber-van Bosse & Foslie) Weber-van Bosse & Foslie in Foslie, Siboga-Exped. Monogr. 61: 49–51, t. 10, f. 21, 3–5, 1904.

Porolithon reinboldii (Weber-van Bosse & Foslie) Lemoine, Ann. Inst. Oceanogr. [Monaco] 2(*2*): 166–169, 1911.

Spongites reinboldii (Weber-van Bosse & Foslie) D. Penrose & W.J. Woelkerling, Phycologia 27: 173, t. 2, 1988.

Type locality: Muaras Reef, Borneo Bank, Indonesia. (*fide* Silva *et al.* 1996).

Diagnosis: The thallus is characterized by a pale greyish-blue-violet to pale bluish-violet rough-textured large knobbed surface, having 5–10 cm in diam., occurs either as a calcareous crust on dead limestone reef or ranges from small fragments up to fist-sized nodules. Hypothallium comprised of vertically elongated cells about 10–15 µm in diam., perithallium composed of irregularly rounded cells of 16–25 µm in diam. Nodules are formed (as are the nodules of other crustose coralline seaweeds) when the spores of the seaweed settle on and grow over loose reef rubble fragments that are rolled about by waves or surge as the seaweed grows.

Material examined: Two specimens.

Season: Post-monsoon.

Habitat: Occurs over the entire reef flat, extending into waters 20 m deep.

Distribution: Baga.

8. ***Mesophyllum erubescens*** (Foslie) Lemoine, Bull. Soc. Bot. France 75: 252, 1928; Tseng, Common seaweeds of China 316, 1983.

Lithothamnion erubescens Foslie, K. Norske Vid. Selsk. Skr. 1899 (5): 9, 1900; Untawale *et al.,* List of marine algae from India, 42, f. 36, 1983.

Type locality: Chaloup Bay, Fernando de Noronha (*fide* Silva *et al.* 1996).

Diagnosis: Thin, dark pink somewhat leafy crust measuring about 5–7 cm, surface usually non-lustrous, undulate, sometimes developing random low knobs. Epithallium single layer of rounded cells, 3–4 µm long and 4–7 µm in diam. Intercalary meristem elongate; cells 4–5 µm long and 5–6 µm in diam. Perithallium multilayered, irregular; cells somewhat square, 2–10 µm long and 3–9 µm in diam. Hypothallium weakly coaxial 20–60 µm thick; cells 7–27 µm long and 5–12 µm in diam. Tetrasporangial conceptacles multipored, low and rounded domes, epithallium persistent.

Material examined: Five specimens.

Season: Post-monsoon.

Habitat: Found on huge rocks in low tide zones.

Distribution: Cabo-de-Rama.

Remark: According to Athanasiadis and Ballantine (2014), this species is a taxonomic synonym of *Melyvonnea erubescens* (Foslie).

9. ***Chondracanthus acicularis*** (Roth) Fredericq in Hommersand *et al.,* Hydrobiologia 260/261: 117, 1993; Sahoo *et al*., Seaweeds of the Indian Coast 283, 2001; Jha *et al.,* Diversity Distr. Seaweeds Guj. Coast 215, 2009.

Fucus acicularis Wulfen, Crypt. Aquat.: 63, 1803. nom.illeg.

Ceramium aciculare Roth, Cat. Bot. 3: 114, 1806.

Gigartina acicularis (Roth) Lamouroux, Ann. Mus. Hist. Nat. [Paris] 20: 136, 1813; Sreenivasa Rao & Kale, Phykos, 8: 71–82, f. 35, 1970; Børgesen, Dan. Vidensk. Selsk. Biol. Med. 12: 64, 1935; Untawale *et al.,* List of marine algae from India, 42, f. 36, 1983.

Sphaerococcus acicularis (Roth) C. Agardh, Syn. t. 16, 1817.

Mamillaria acicularis (Roth) Kuntze, Rev. Gen. t. 2: 902, 1981.

Type locality: Adriatic Sea (*fide* Silva *et al*. 1996).

Diagnosis: Plants forming clumps or mats, dark purple or reddish brown, 3–5 cm tall, branching irregularly dichotomous or pinnate, secund; branches terete or subterete towards apices, 2 mm in diameter, partly procumbent with ultimate branches often recurved and forming attachment discs on contacting the substratum.

Material examined: 25 specimens.

Season: Monsoon and Post-monsoon.

Habitat: Occurs as cushion-like clumps on wave exposed rocks in lower parts of upper eulittoral subzone.

Distribution: Chapora, Vagator, Anjuna, Baga, Reis Magos, Dona Paula, Siridao, Mormugao, Bogmalo, Holant, Betul, Cabo-de-Rama, Palolem, Polem, Chicalim Bay.

10. ***Hypnea flagelliformis*** Greville ex J. Ag., Sp. Alg. 446, 1851; Børgesen, J. Indian Bot. Soc. 17: 205–242, t. 7, f. 3, 1938; Untawale *et al*., List of marine algae from India, 42, f. 36, 1983; Kaliaperumal *et al*., Seaweed Res. Util., 14: 103–107, t. 1, 1992; Jha *et al*., Diveristy Distr. Seaweeds Guj. Coast 215, 2009.

Hypnophycus flagelliformis (Greville ex J. Agardh) Kuntze, Revisio generum plantarum, 900, 1891.

Type locality: "ad littus Hindostaniae" [India] (*fide* Silva *et al.* 1996).

Diagnosis: Plants often solitary or in loose clumps, 8–16 cm long, branches 1 mm diameter, irregularly divided few times near base, gradually attenuate towards tips; branchlets absent in uppermost parts of branches, long and sometimes divided near the base of branches, becoming shorter and spine-like towards branch tips.

Material examined: Four specimens.

Season: Post-monsoon.

Habitat: Occurs on moderately wave exposed rocks in the lower subzone and becomes abundant in case of wave surge.

Distribution: Anjuna, Baga.

11. ***Ahnfeltiopsis pygmaea*** (J. Agardh) P.C. Silva & DeCew, Phycologia 31: 578, 1992; Sahoo *et al*., Seaweeds of the Indian Coast 283, 2001.

Gymnogongrus pygmaeus J. Agardh, Sp. Alg. 2: 317, 1851; Krishnamurthy & Joshi, A Checklist of Marine Algae, 36, 1970; Kalimuthu *et al*., Seaweed Res. Util. 15: 119–126, t. 2, f. 1, 1992.

Type locality: India (*fide* Coppejans *et al*. 2009).

Diagnosis: Plant gregarious, growing in isolated bushy clusters; well-developed specimens are densely intricated; attachment by means of discoid holdfasts; thalli erect, 2–2.5 cm high, of rubbery texture, cylindrical at the base, slightly compressed higher up, 0.5 mm in diameter, repeatedly dichotomously branched in a single plane; marginal proliferations absent; dark red. Medulla pseudoparenchymatous with all cells approximately of the same size and shape, cortex thick and composed of radially arranged filaments of small cells. Cystocarps intercalary on slightly widened parts of branches often situated proximal to a dichotomy, deeply embedded in branches, with multiple carpostomes.

Material examined: Two specimens.

Season: Post-monsoon.

Habitat: Sloping rock surfaces along surf-exposed coasts, at about mid-intertidal; continuously waveswept.

Distribution: Chapora, Polem.

12. ***Antithamnion cruciatum*** (C. Agardh) Nägeli, Neue Denkschr. Allg. Schweiz. Ges. Gesammten Naturwiss. 9[2]: 202, 1847; Børgesen, F. *Det Kgl. Danske Videnskabernes Selskab. Biologiske Meddelelser*. Kobenhaven, 159, 1930; Subramanian, Marine Plants (Eds: Krishnamurthy, V. & A.G. Untawale) 191–204, f. 51, 1985; Sahoo *et al.*, Seaweeds of the Indian Coast 283, 2001.

Calithamnion cruciatum C. Agardh, Flora 10: 637, 1827.

Type locality: Trieste, Italy (*fide* Silva *et al.* 1996).

Diagnosis: Plants tufted, height up to 3 cm, colour dull rose red, alternately and sparingly divided, branches long, at the tips branchlets densely tufted or appearing ocellate-congested; main axis below 50–90 µm in diam., cells 90–300 µm long; lateral branches short, spreading, of even length, opposite in alternately placed pairs; branchlets alternate, in 2 rows; tetrasporangia sessile or briefly stalked, 75–85 µm long, 50–55 µm in diam, mostly on the upper side of the short branches.

Material examined: Five specimens.

Season: Post-monsoon.

Habitat: Found on stones and coarse algae.

Distribution: Dona Paula, Chicalim Bay Island.

13. ***Gayliella flaccida*** (Harvey ex Kützing) Cho & McIvor in T.O. Cho, S.M. Boo, M.H. Hommersand, C.A. Maggs, L. McIvor & S. Fredericq, J. Phycol. 44: 723, 2008; Fernández-García *et al.*, Bot. Mar. 54: 53–73, 2011.

Ceramium flaccidum (Kützing) Ardissone, Nuovo Giorn. Bot. Ital. 3: 40, 1871; Sahoo *et al.*, Seaweeds of the Indian Coast 283, 2001.

Hormoceras flaccidum Kützing, Tab. Phycol. 12: 21, t. 69: f. a–d, 1862.

Ceramium gracillimum Griffiths & Harvey ex Harvey, 1848, Gómez Garreta *et al.*, Bot. Mar. 44: 425–460, 2001; Børgesen, Bull. Misc. Info., Royal Bot. Garden 30, 1934.

Ceramium masonii E.Y. Dawson, Farlowia 4: 126–127, t. 2, f. 11, 12, 1950.

Type locality: Kilkee, County Clare, Ireland (*fide* Silva 2012).

Diagnosis: Plants forming small tufts, about 5 cm tall; branches alternately or dichotomously divided, apices forcipate; nodal bands 130 µm in diameter, 70 µm in length, consisting of lowermost row of quadrate or angular cells, separated by a clear space from a row of large, elongated cells, gland cells present, axial cells 3–4 times longer than broad; tetrasporangia often prominent and whorled.

Material examined: Ten specimens.

Season: Post-monsoon.

Habitat: Occurs with other species of *Ceramium* found growing on crustose coralline algae on the lower eulittoral subzone.

Distribution: Dona Paula, Mormugao, Holant, Cabo-de-Rama, Palolem, Talpona, Polem.

14. ***Crouania attenuata*** (C. Agardh) J. Agardh, Alg. Mar. Medit.: 83, 1842; Untawale *et al.*, List of marine algae from India, 42, f. 36, 1983.

Mesogloia attenuata C. Agardh, Syst. Alg.: 51, 1824.

Type locality: France: Brittany (*fide* Silva 2012).

Diagnosis: Plants 1–1.5 cm high, either tufted or entangled with other algae, filaments 0.2–0.3 mm diam., much branched, tetraspores single, on the basal cell of the fascicle of the ramuli.

Material examined: Four specimens.

Season: Post-monsoon.

Habitat: Common on stone or brickwork or on larger algae in shallow water.

Distribution: Dona Paula, Chicalim Bay.

15. ***Wrangelia argus*** (Montagne) Montagne, Sylloge Generum Specierumque Cryptogamarum: 444, 1856; Børgesen, J. Indian Bot. Soc., 16: 311–357, f. 20, 1937; Umamaheshwara Rao & Sreeramulu, Bot. J. Linn. Soc. 63: 23–45, f. 65, 1970; Chauhan & Mairh, Salt Res. Ind. 14(2): 21–41, t. 11, f. 5, 1978.

Griffithsia argus Montagne, Histoire Naturelle des Iles Canaries: 176, t. 8, f. 4, 1841.

Type locality: Roque del Gando, Islas Canarias (*fide* Silva *et al.* 1996).

Diagnosis: Thalli purplish red-green often iridescent, turf-like colonies, soft texture, 1–1.5 cm tall; Main axis percurrent, alternately and pinnately branched, 0.45 to 6 mm in diam., with internodes 2–3 diameters in length, lower portions of axis and main branches covered with cortical layer formed by rhizoidal filaments. Younger portions not corticated, branches verticillate. Tetrasporangia sessile, borne on verticillate branches, tetrahedrally divided, spherical to ovoid.

Material examined: Single specimen.

Season: Post-monsoon.

Habitat: Found on corals and coral debris subtidally between 4 and 30 m depth.

Distribution: Dona Paula.

16. ***Dasya ocellata*** (Grateloup) Harvey, Brit. Fl. 335, 1833; Untawale *et al.*, List of marine algae from India, 42,

f. 36, 1983; Sahoo *et al.*, Seaweeds of the Indian Coast. 283, 2001.

Ceramium ocellatum Grateloup, Descriptiones aliquorum Ceramiorum novorum, cum iconum explicationibus.1806: f. 2, 1806.

Hutchinsia ocellata (Grateloup) C. Agardh, Syst. 157, 1824.

Type locality: Sète, Hérault, France (*fide* Silva 2012).

Diagnosis: Plants bushy, reddish purple, 2 cm tall, lightly to densely branched, sparingly alternate branching; axes heavily corticated; ramelli irregularly disposed over the cortex, dichotomously branched, attenuate towards tips; stichidia on 1–2 celled stalks on the lower divisions of ramelli.

Material examined: Two specimens.

Season: Post-monsoon.

Habitat: Shallow water plant, growing on mangrove roots or Sargassum plants.

Distribution: Dona Paula.

17. ***Caloglossa ogasawaraensis*** Okamura, Bot. Mag. [Tokyo] 11: 12, text-figs. A–D, 1897; Sahoo *et al.*, Seaweeds of the Indian Coast 283, 2001.

Delesseria zanzibariensis K.I.Goebel, Flora, 85: 67, f. 1–6, 1898.

Caloglossa zanzibariensis (Goebel) De Toni, Syll. Alg. 4: 731, 1900.

Caloglossa bombayensis Børgesen, Bull. Misc. Inform. [Kew] 1933: 127–129, f. 10–12, 1933; Lewis, Checklist and bibliography of benthic marine macroalgae recorded from northern Australia I. Rhodophyta. 1–98, 1984; Krishnamurthy & Joshi, A Checklist of Marine Algae, 36, 1970; Chaugule & Gunale, M.V.M. Patrika, 16 (1&2): 5–14, 1981.

Type locality: Bonin Islands, Japan (*fide* Silva 2012).

Diagnosis: Thallus brown-red, forming loose entangled mats 5–10 mm thick, composed of slightly arching, flat, linear branches 100–200 µm broad, internodes 1–4 mm long between slightly constricted nodes; attached by uniseriate rhizoids. Growth apical, with a dome-shaped apical cell cutting off axial cells and lateral and transverse pericentral cells; secondary pit-connections frequent. Blades monostromatic apart from the midrib, margins entire. Branching of blades exogenous near apices with adventitious proliferous blades arising from nodal pericentral cells. Gametophytes dioecious; Cystocarps sessile, ovoid. Spermatangial sori produced on both sides of the blades.

Material examined: Two specimens.

Season: Post-monsoon.

Habitat: Epiphytic on *Avicennia* pneumatophores or on mud below mangroves.

Distribution: Chicalim Bay.

18. ***Erythroglossum lusitanicum*** André, Portugaliae Acta Biologica sér. B, 10: 137–555, 1970; Barbara *et al.*, Anales del Jardín Botánico de Madrid 62: 69–100, 2005; Araujo *et al.*, Botanica Marina 52: 24–46, 2009; Bárbara, Algas Bentónicas Marinas Y Salobres De Galicia: Índice 429, 2009.

Type locality: Buarcos, Portugal (*fide* Guiry & Guiry 2012).

Diagnosis: Thallus membranous, flattened, with pinkish red fronds, measuring *c.* 3–4 cm, arising from a discoid base bearing a stipe, from which arise irregular lateral elongate proliferations and erect ovate to oblanceolate blades with a midrib. The lobes are deeply cleft into wedge-shaped segments about 0.4 cm in breadth at the base. Blades simple and ovate-oblanceolate. Presence of a faint midrib, veins anastomosing, microscopic veins present in young parts. Some proliferations have discrete patches of rhizoids, and thalli form elaborate creeping rhizomatous bases. As a mode of regeneration, old blades bear young blades irregularly located along margins of basal parts and on broken tips. Thallus usually alternately branched and produces proliferations from margin.

Material examined: Three specimens.

Season: Post-monsoon.

Habitat: Grows on sand-covered rocks in exposed sites.

Distribution: Mormugao, Polem.

Remark: This species was confirmed with the help of Barbara's (2009) description. The plant differs from *Hypoglossum*, a similar plant, due to the presence of proliferations from the margins and not the midrib. This is the first record of this species for the Indian Coast.

19. ***Herposiphonia secunda*** (C. Agardh) Ambronn forma *tenella* (C. Agardh) Wynne, Cryptogamie: Algologie 5: 173, 1985.

Hutchinsia tenella C. Agardh, Sp. Alg. 2: 105, 1828.

Polysiphonia tenella (C. Agardh) Moris & De Notaris, Memorie della Reale Accademia delle Scienze di Torino, ser. 2, 2: 265, 1839.

Herposiphonia tenella (C. Agardh) Ambronn, Bot. Zeit. 38: 197, 1880; Taylor, Mar. Algae East. Trop. Subtrop. Coasts Amer. 870, t. 80, 1960; Papenfuss, Israel Journal of Botany 17: 1–118, t. 1, map 1, 1968; Abbott & Hollenberg, Marine Algae of California, 827, 1976; Untawale *et al.*, List of marine algae from India, 42, f. 36, 1983.

Type locality: Sicily (*fide* Silva 2012).

Diagnosis: Plant small, about 1–2 cm tall, closely attached to the substratum, usually forming close mats; colour purplish; branching of main axis irregularly alternate, apices slightly upcurved; axes 100–150 µm in diameter, either an erect ramulus or an indefinite branch, 1 to 3 ramuli alternating with an indefinite branch; ramuli 35 to 45 segments, 5–7 mm long, 65–90 µm diameter, with 12 to 14 pericentral siphons; tetrasporangia in a long series on the ramulus.

Material Examined: 10 specimens.

Season: Post-monsoon.

Habitat: Found as tufts in crevices of rocks in midtidal zone.

Distribution: Vagator, Anjuna, Baga, Polem.

20. ***Vaucheria longicaulis*** Hoppaugh, American Journal of Botany 17: 329–347, t.24–27, f. 2, 1930; Silva *et al.*, Cat. Benthic Marine Algae Indian Ocean. 79: 1,259, 1996.

Type locality: Eckhorn Slough, Monterey County, California (*fide* Silva 2012).

Diagnosis: Thalli made up of green mats consisting of microscopic siphons. Oogonia form club-like terminal swellings on vegetative filaments. Asexual sporangia (aplanosporangia) resemble oogonia but have a smaller diameter and increase gradually from the width of the vegetative filaments. The asexual sporangia are wider than the oogonia, ranging between 80 and 170 µm. Antheridia are cylindrical.

Material examined: Single specimen.

Season: Monsoon.

Habitat: Found on intertidal mud flats or below low tide level. A rare alga; has been reported from Siridao during monsoon.

Distribution: Siridao.

21. ***Dictyota ceylanica*** Kützing, Tab. Phycol. 9: 11, t. 25, f. I, 1859; Misra, In: Proc. Sem. Sea, Salt & Plants (Ed.: Krishnamurthy, V.), 227–233, 1967; De Clerck, Opera Bot. Belg. 13: 205, 2003; Coppejans *et al.*, Sri Lankan Seaweeds. 6: 1–8, 1–265, 2009.

Type locality: Sri Lanka (*fide* Silva *et al.* 1996).

Diagnosis: Thalli iridescent or non-iridescent and tan to muddy brown, 1.5–6.5 cm tall. Erect. Axes dichotomous in regular fashion or anisotomous, but never resulting in an alternate branching pattern, 0.5 to 2 mm wide below, gradually or abruptly extending distally or as marginal filiform proliferations; surface proliferations absent.

Material examined: Single specimen.

Season: Post-monsoon.

Habitat: Mostly found in rock pools of the midlittoral region. Exposed rocky areas harbour smaller forms, whereas larger, less entangled forms are found in sheltered areas.

Distribution: Anjuna.

22. ***Dictyota ciliolata*** Sonder ex Kützing, Tab. Phycol. 12, t. 27, f. I, 1859; Misra, In: Proc. Sem. Sea, Salt & Plants (Ed.: V. Krishnamurthy), 227–233, 1967; Chaugule & Gunale, M.V.M. Patrika, 16 (1&2): 5–14, 1981; Untawale *et al.*, List of marine algae from India, 42, f. 36, 1983; Jha *et al.*, Diveristy Distr. Seaweeds Guj. Coast 215, 2009.

Type locality: La Guaira, Venezuela (*fide* Silva *et al.* 1996).

Diagnosis: Plants yellowish brown, 15–20 cm in length, membranous, ribbon-like, upper parts regularly dichotomously branched with a cuneate disc at base. Branches uniformly broad, apices acute to sub-acute, forking angles between branches are round. Margins of branches possess small ascending projections.

Material examined: 12 specimens.

Season: Post-monsoon.

Habitat: Found on rocks and coralline stones in the intertidal zone.

Distribution: Anjuna, Baga, Reis Magos, Dona Paula, Mormugao, Palolem, Polem.

23. ***Dictyota divaricata*** Lamour. J. Bot. [Desvaux] 2: 43. 1809; Taylor, Mar. Algae East. Trop. Subtrop. Coasts Amer. 870, t. 80, 1960; Silva *et al.*, Cat. Ben. Mar. Alg. Ind. Ocean. 79: 14 + 1,259, 1996; Untawale *et al.*, List of Marine algae from India, 42, f. 36, 1983.

Zonaria dichotoma (Hudson) C. Ag. var. *intricata* C. Ag., Sp. Alg. 134, 1820.

Dictyota dichotoma (Hudson) Lamour var. *intricata* (C. Ag.) Greville, Alg. Brit.: 58, 1830; Børgesen, J. Indian Bot. Soc., 16: 1–56, f. 33, 1937; Misra, Phaeophyceae in India, 203, t. 5, f. 100, 1966; Krishnamurthy & Joshi, A Checklist of Marine Algae, 36, 1970; Sahoo *et al.*, Seaweeds of the Indian Coast, 283, 2001.

Dictyota vulgaris (Kütz.) Kütz. var. *intricata* (C. Ag.) Kütz., Phycol. Germ.: 270–271, 1845.

Type locality: Cádiz, Spain (*fide* Silva *et al.* 1996).

Diagnosis: Plants light brown hued, forming entangled clumps, up to 10 cm tall, branching at a divergence of 100°–130° in upper parts, somewhat less below, with many adventitious branches often arising along the margins; branches commonly about 3 mm in width below, abruptly narrowing above to less than 0.5 mm with the tips blunt or rounded; tetrasporangia occurring on both surfaces of thallus. Sporangia are spherical in shape.

Material examined: Three specimens.

Season: Post-monsoon.

Habitat: Grows on rocks in shallow puddles of the midlittoral region; also in the sublittoral fringe in sheltered conditions. The plants found at shallow depths have a marked bluish iridescence.

Distribution: Baga, Cabo-de-Rama.

Remark: According to Tronhom *et al.* (2010), this species is a taxonomic synonym of *Dictyota implexa* (Desfontaines) J.V. Lamouroux.

24. ***Padina australis*** Hauck, Hedwigia 26: 44, 1887; Silva *et al.*, Cat. Ben. Mar. Alg. Ind. Ocean 79: 1,259, 1996.

Type locality: Cape York, Queensland, Australia (*fide* Silva 2012).

Diagnosis: Thalli erect or dissected into basally constricted flabellate lobes from a fibrous holdfast and a short stupose stalk or almost horizontally spreading, sessile, frequently overlapping and broad at base. Plants pale to dark brown, up to 11 cm in length, *c.* 10.5 cm wide, broadly lobed, lightly calcified ventrally. Apical margins circinnately coiled. Fronds *c.* 90–100 µm thick. Cells of dorsal and ventral layers almost uniform in size. Reproductive bodies in sori alternating on dorsal and ventral side of blade between hair bands, leaving a sterile intercalary band.

Material examined: Seven specimens.

Season: Pre-monsoon and Post-monsoon.

Habitat: Grows in sheltered places between rocks.

Distribution: Baga, Reis Magos, Holant, Betul.

25. ***Chnoospora minima*** (Hering) Papenfuss, Journal of South African Botany 22: 69–70, 1956; Sahoo *et al.*, Seaweeds of the Indian Coast 283, 2001.

Fucus minimus Hering, Ann. Mag. Nat. Hist. 8: 92, 1841.

Chnoospora pacifica J. Ag., Öfvers. K. [Svenska] Vet.-Akad. Förh. 4: 7. 1847; Dawson, Allan Hancock Pacific Expeditions 3: 1–5, 189–432, t. 31–77, 1944.

Chnoospora fastigiata J. Ag., Sp. Alg. 171–172, 1848. nom. illeg; Børgesen, J. Ind. Bot. Soc. 17: 205–242. t. 7–8, f. 13, 1938; Krishnamurthy & Joshi, A Checklist of Marine Algae, 36, 1970.

C. fastigiata J. Ag. var. *pacifica* (J. Ag.) J. Ag., Sp. Alg. 172, 1848; Børgesen, In: Natural History of Juan Fernandez and Easter Island. (Ed: Skottsberg, C.) 2: 247–309, 1924; Umamaheshwara Rao & Sreeramulu, J. Ecol. 52: 595–616, t. 2, f. 7, 1964.

Type locality: Port Natal, South Africa (*fide* Silva *et al.* 1996).

Diagnosis: Thalli yellow brown, erect, about 5 cm tall, almost dichotomously branched, not entangled, attached by small holdfasts. Branches subcylindrical, compressed in the joints, *c.* 1 mm broad with numerous colourless hairs arising from superficial depressions, ultimate branchlets with acute apices. Rectangular cells with chromatophores present around layers of irregularly shaped larger cells. Plurilocular sporangia scattered on surface of thalli.

Material examined: Three specimens.

Season: Post-monsoon.

Habitat: Grows on exposed lower intertidal rocks.

Distribution: Chapora.

26. ***Colpomenia sinuosa*** (Mertens ex Roth) Derbès & Solier in Castagne, Supplément au catalogue des plantes qui croissent naturellement aux environs de Marseille: 95, 1851; Børgesen, Bull. Misc. Info., Royal Bot. Garden 30, 1934; Misra, In: Proc. Sem. Sea, Salt & Plants (Ed.: V. Krishnamurthy), 227–233, 1967; Krishnamurthy & Joshi, A Checklist of Marine Algae, 36, 1970; Chauhan, Salt Res. Ind. 14(1): 1–10, map, t. 2, 1978; Solimabi & Naqvi, Mahasagar - Bull. Natl Inst. Ocean. 8: 97–99, t. 1, 1975; Agadi & Untawale, Seaweed Res. Util. 3: 56–70, f. 3, t. 2, 1978; Kalimuthu *et al.*, Seaweed Res. Util. 15: 119–126, t. 2, f. 1, 1992; Jha *et al.*, Diversity Distr. Seaweeds Guj. Coast 215, 2009.

Ulva sinuosa Mertens ex Roth, Cat. Bot. 327, t. 12, 1806.

Encoelium sinuosum (Mertens ex Roth) C. Agardh, Sp. Alg. 146, 1820.

Asperococcus sinuosus (Mertens ex Roth) Bory, Botanique: 326, 1832.

Hydroclathrus sinuosus (Mertens ex Roth) Zanardini, Saggio di classificazione naturale delle Fice...: 39, 1843; Piccone, Elenco delle alghe della Crociera del Corsaro alle Baleari. pp. [1]–22, 1889.

Type locality: Near Cadiz, Spain (*fide* Silva *et al.* 1996).

Diagnosis: Plants light yellowish brown, solitary or clustered, sessile, spherical, becoming lobed, or irregularly expanded, individually reaching a diameter of 1–12 cm, more or less compressed, surface of thalli smooth when young, somewhat corrugated when old, sessile, the wall 0.3–0.4 mm thick, cortical cells cuboidal or polygonal, small with chromatophores, medullary cells large, rounded, colourless. Gametangia growing around hairy filaments during intital stage, later spreading over the thallus, usually biseriate.

Material examined: 10 specimens.

Season: Post-monsoon.

Habitat: Grows on intertidal rocks in exposed conditions.

Distribution: Reis Magos, Siridao.

Uses: Traditionally consumed wholly as food, now used as a fertilizer and source of alginates.

27. ***Ulva conglobata*** Kjellman, Bih. Kongl. Svenska Vetensk.-Akad. Handl. 23 (Afd. 3, 11): 10–11, t. 2: f. 1–7; t. 3: f. 9–14, 1897; Ohno & Mairh, Reports Usa Mar. Biol. Inst. 4: 1–8, t. 5, f. 4, 1982; Jha *et al.*, Diversity Distr. Seaweeds Guj. Coast 215, 2009.

Type locality: Various in Japan (*fide* Silva *et al.* 1996).

Diagnosis: Thalli bright green, subcartilaginous below, membranous above, caespitose and expanding in almost globular mass, 2–4 cm tall. Membrane 30–50 µm thick at upper side and about 100–125 µm thick at the base. Cells rectangular and vertically elongated.

Material examined: 32 specimens.

Season: Monsoon, Post-monsoon.

Habitat: Grows in upper and middle intertidal rocks covered with sand.

Distribution: Terekhol, Chapora, Vagator, Anjuna, Baga, Reis Magos, Dona Paula, Siridao, Mormugao, Bogmalo, Holant, Betul, Cabo-de-Rama, Palolem, Talpona, Chicalim Bay.

28. ***Ulva rigida*** C. Ag., Sp. Alg. 410–411, 1823. Jagtap, Indian J. Mar. Sci. 21: 56–58, 1992; Silva *et al.*, Cat. Benthic Mar. Algae Indian Ocean 79: 1,259, 1996.

Ulva lactuca Linnaeus var. *rigida* (C. Ag.) Le Jolis, Mém. Soc. Imp. Sci. Nat. Cherbourg 10: 38, 1863; Børgesen, F. (1926 '1925'). *Konge. Dan. Vidensk. Selsk. Biol. Med.*, 5(3): 1–123, f. 49; Lewis & Gonsalves, New Phytologist, 61: 288–290, t.2, 1962; Kale & Krishnamurthy, Salt Res. Ind., 3:14, 1966.

Phycoseris ulva Sonder, Bot. Zeit. 3: 49, 1845.

Phycoseris gigantea Kützing var. *perforata* Kützing, Sp. Alg: 476, 1849.

Ulva australis Areschoug, Nova Acta R. Soc. Sci. Upsal., Ser. 3, 1: 370. 1854.

Letterstedtia petiolata J. Agardh, Alg. Syst. 19(*2*): 176–177, t. 4, f. 123, 124. 1883; Chapman, J. Linnean Soc. of London, Botany 55: 333–501, t. 24–50, f. 153, 1956.

Ulva spathulata Papenfuss, J. Linn. Soc. London, Bot. 56: 309, 1960; Womersley, H.B.S. Mar. Benthic Flora Southern Australia. I: 329, t. 16, f. 102, 1984.

Type locality: Cadiz, Spain (*fide* Papenfuss 1960).

Diagnosis: Blades pale to dark olivaceous, drying to black, firm and comparatively rigid, ovate to ovate-lanceolate, at times circular, highly dissected single or multiple fronds from a basal holdfast, 3–10 cm tall, 10–30 cm broad, 40–60 µm thick, commonly with short, distinct stipe; margins smooth to variously incised but lacking minute teeth; cells irregularly arranged, 10–15 µm in diameter, 2 layers of blade separated by pronounced accumulation of mucilaginous material; chloroplast with 1–2 pyrenoids; gametes may be of anisogamous nature.

Material examined: 15 specimens.

Season: Post-monsoon.

Habitat: Occurs in eulittoral zone on rocks and stranded logs. Grows extensively in exposed zones; occasionally extending into the littoral zone.

Distribution: Chapora, Vagator, Anjuna, Reis Magos, Cabo-de-Rama.

29. ***Ulva taeniata*** (Setchell) Setchell *et* Gardner, Univ. Calif. Publ. Bot. 7: 286, 1920; Mantri *et al.,* Curr. Sci. 93.6: 773–774, 2007.

Ulva fasciata f. *taeniata* Setchell in Collins, Holden, & Setchell, Phycoth. Bor. Amer.: no. 862, 1901.

Type locality: Monterey, California, USA (*fide* Silva 2012).

Diagnosis: Thallus rigid, pale green in colour, up to 12 cm tall, irregularly lobed; lobes 0.5–3.5 cm broad with crisply ruffled appearance. Basal portion of the frond long, slender and divided, with distinctly dentate or wavy margin. Fronds are attached with round to oval greenish-brown discs, which are about 3–4 mm in diameter. In surface view, the polygonal vegetative cells are compactly arranged without any intercellular space, 14–32 mm in diameter.

Material examined: Four specimens.

Season: Post-monsoon.

Habitat: Grows on rocks located in the mid-tide zone.

Distribution: Mormugao.

30. ***Chaetomorpha spiralis*** Okamura, Algae Japonicae Exsiccatae: No. 94 (Bot. Mag. [Tokyo], 17: 131, 1903; Jha *et al.,* Diversity Distr. Seaweeds Guj. Coast 215, 2009.

Chaetomorpha clavata Kützing var. *torta* Farlow ex Collins, Tufts Coll. Stud. (Sci.) 2: 323, 1909.

Chaetomorpha torta (Farlow ex Collins) Yendo, Bot. Mag. [Tokyo] 28: 264–265, 1914; Untawale *et al.*, List of marine algae from India, 42, f. 36, 1983; Lewis, Revue Algologique, Ser. 2, 7:15–25, t. 3, 1963; Umamaheshwara Rao & Sreeramulu, J. Ecol. 52: 595–616, t. 2, f. 7, 1964; Krishnamurthy & Joshi, A Checklist of Marine Algae, 36, 1970.

Type locality: Japan (*fide* Silva *et al.* 1996).

Diagnosis: Some plants gregarious, others solitary, 4–

5 cm long, growing in open populations between other algae; basal parts of the stiff, unbranched filaments coiled or at least markedly sinuous, dark green; upper parts straight or slightly sinuous, light green; diameter in the basal parts 450–600 μm, where the cells are cylindrical and isodiametric, gradually becoming bead-like and reaching a diameter of 1 mm at the filament apices.

Material examined: Two specimens.

Season: Post-monsoon.

Habitat: In shallow, low intertidal rock pools with sandy bottom; continuously wave-swept.

Distribution: Terekhol, Anjuna, Baga, Dona Paula.

31. ***Cladophora glomerata*** (L.) Kützing, Phycol. General.: 266, 1843; Patnaik, Proc. Natl. Acad. Sci. Sec. B., 43: 53–65, t. 1, f. 3, 1973; Murthy *et al.*, Bot. Mar. 21: 381–386, f. 6, 1 map, 1978; Skinner & Entwisle, Telopea 10(3): 731–748, 2004.

Conferva glomerata Linnaeus, Sp. Pl.: 1167, 1753.

Polysperma glomerata (Linnaeus) Vaucher, Hist. Conferv.: 99, 1803.

Chantransia glomerata (Linnaeus) A.P. de Candolle in Lamarck & A.P. de Candolle, Fl. Franç., ed. 3, 2: 51, 1805.

Annulina glomerata (Linnaeus) Nees, Horae Phys. Berol. [Index p. 1], 1820.

Type locality: Europe (*fide* Silva *et al.* 1996).

Diagnosis: Thallus attached to rocks, stones, boulders or other solid substrate by means of rhizoids; hardly free floating; frequently branched; yellowish green; branches feather-like, curved inwards towards upper part, branchlets many and are further divided, older branches falsely dichotomous, primary branch varying from 60–125 μm in diameter, intermediate branches 20–75 μm in diameter, apical branches 20–35 μm in diameter; cell membrane thick, fibrillose, apical cells obtusely rounded.

Material examined: Four specimens.

Season: Post-monsoon.

Habitat: Epilithic, on sand or mud covered shallow pools in intertidal zone. Cosmopolitan, reported from both freshwater and saline habitats.

Distribution: Baga, Siridao, Chicalim Bay.

32. ***Cladophora herpestica*** (Montagne) Kützing, Sp. Alg. 15, 1849; Fernández-García *et al.*, Bot. Mar. 54: 53–73, 2011.

Conferva herpestica Montagne, Prodromus generum specierumque phycearum novarum, in itinere ad polum antarcticum... collectarum...: 15, 1842; Leliaert & Coppejans, *Phycologia*, 45: 657–679, 2006.

Cladophoropsis herpestica (Montagne) Howe, Mem. Torrey Bot. Club 15: 31, 1914; Silva *et al.*, Cat. Benthic Mar. Alg. Ind. Ocean, 79: 1–1259, 1996; Coppejans *et al.*, Sri Lankan Seaweeds Methodologies and field guide to the dominant species. 6: 265, 2009.

Aegagropila javanica Kützing, Flora, 30: 773, 1847; Leliaert & Coppejans, Phycologia 45: 657–679, 2006.

Cladophora zollingeri Kützing, Sp. Alg.: 415, 1849; Papenfuss, Israel Journal of Botany 17: 1–118, table 1, 1968.

Aegagrophila zollingeri (Kützing) Kützing, Tabulae phycologicae 4: 14, t. 64: f. 2, 1854.

Siphonocladus zollingeri (Kützing) Bornet ex De Toni, Sylloge algarum...I. Chlorophyceae: 359, 1889.

Cladophoropsis zollingerii (Kützing) Reinbold *Nuova Notarisia*, 16: 147, 1905; Børgesen, 1933; Sreenivasa Rao & Kale, Phykos, 8: 71–82, f. 35, 1970; Chaugule & Gunale, M.V.M. Patrika, 16 (1&2): 5–14, 1981; Chaugule *et al.*, Seaweed Res. Util. 11: 107–115, t. 3, f. 58, 1989; Untawale *et al.*, List of marine algae from India 42, f. 36, 1983.

Cladophoropsis javanica (Kützing) Silva, Basson & Moe, 1996 (l. c); Sahoo *et al.*, Seaweeds of the Indian Coast 283, 2001.

Type locality: Java, Indonesia (*fide* Silva 2012).

Diagnosis: Plants yellowish to dark green in colour, occurring as cushions or tufts, entangled uniseriate, without a distinct main axis; measuring 2–20 cm across and 1–2 cm high; attached by a multicellular hapetra, erect filaments abundantly branched; apical cells and cells of the terminal branch systems subcylindrical, generally curved or sinuous, 120–450 μm in diameter, up to 10 mm long; branches without basal wall near the base of branches, cells large with numerous nuclei and scattered chloroplast.

Material examined: 10 specimens.

Season: Post-monsoon.

Habitat: Epilithic, just above low water mark, exposed to air at low tide but continuously wave-swept; surf exposed coasts.

Distribution: Anjuna, Dona Paula, Holant, Talpona, Polem.

33. ***Cladophora lehmanniana*** (Lindenberg) Kützing, Phycol. General: 268, 1843; Sahoo *et al.*, Seaweeds of the Indian Coast 283, 2001.

Conferva lehmanniana Lindenberg, Linnaea 14: 179–180, t. 2, 1840.

Cladophora utriculosa Kützing, Phycol. General.: 269, 1843; Taylor, Mar. Algae East. Trop. Subtrop. Coasts Amer. 870, t. 80, 1960; Børgesen, Kongelige Danske Videnskabernes Selskab, Biologiske Meddelelser 5(3): 1–123, f. 49, 1935; Untawale *et al.*, List of marine algae from India, 42, f. 36, 1983.

Cladophora ramulosa Meneghini, Giornale Botanico Italiano Anno 1 Tomo 1(1): 306, 1844; Papenfuss, Israel Journal of Botany 17: 1–118, 1968.

Type locality: Helgoland, Germany (*fide* Silva *et al.* 1996).

Diagnosis: Thallus light to medium green, *c.* 3 cm high, singly or as clustered tufts of several plants, attached by rhizoids from the basal and adjacent cells; epilithic; filaments tapering only slightly, much branched above from almost every cell, forming fastigiate to spreading tufts, filaments almost straight. Growth acropetal and mainly apical, with intercalary divisions in lower cells; laterals first arising 1–3 cells from apex, ultimately with each parent cell bearing 1–3 laterals of varying length. Cross walls arising and remaining oblique to parent cell. Reproduction by apical or sub-apical cells developing into slightly swollen or clavate zooidangia. Apical cells about 70–90 µm in diameter.

Material examined: Six specimens.

Season: Monsoon and Post-monsoon.

Habitat: Occurs on rough water rock platforms and extending to 25 m deep.

Distribution: Bogmalo, Cabo-de-Rama, Talpona.

34. ***Cladophora prehendens*** Kraft & A. Millar, Austral. Syst. Bot. 13: 545, f. 15A–D, 2000; Kraft, Marine Algae of Lord Howe Island and the Southern Great Barrier Reef, 1. Green Algae - Algae of Australia 358, 2007.

Type locality: Lord Howe Island (*fide* Silva 2012).

Diagnosis: Plants pale green, soft, about 5 mm long. Thalli solitary or aggregated, anchored by digitate, non-septate rhizoidal outgrowths from the basal cell which spread over the host surface. Hapteral digitations ending in fine processes that extend into a stolon, developing a digitate pad on further solid contact. Branching generally acropetal. Branches broadly incurved. Ultimate branches 1–7 celled and young plants with 8 cells, apical cells about 13–15 µm in diameter. Segments cylindrical, slightly clavate, articulations slightly constricted, without annulations. Apical cells linear or sharply tapering.

Material examined: Two specimens.

Season: Post-monsoon.

Habitat: Epiphytic on various green (also *Cladophora* sp.), brown, and red algae.

Distribution: Cabo-de-Rama.

35. ***Cladophora socialis*** Kützing, Sp. Alg.: 416, 1849; Rao & Umamaheshwara Rao, Ind. J. Mar. Sci. 15: 102–106, f. 4, 1986; Sahoo *et al.*, Seaweeds of the Indian Coast 283, 2001.

Aegagropila socialis (Kützing) Kützing, Tab. Phyc., 4:15, 1854.

Cladophoropsis infestans Setchell, Carnegie Inst. Wash., Dept. Mar. Biol. 341: 177, text-fig. 41. 1924; Leliaert & Coppejans, Phycologia 45: 657–679, 2006.

Type locality: Tahiti (*fide* Silva *et al.* 1996).

Diagnosis: Thallus medium to dark green, forming 0.5–1 cm thick prostrate mats, composed of interwoven, densely branched filaments. Thallus loosely attached to the substratum by branched or unbranched, uni- or multicellular rhizoids arising from the basal poles of the short cells of the stolon-like filaments. Apical cells cylindrical with rounded tip, 25–50 µm in diameter; basal cells cylindrical, 60–120 µm in diameter. Basal filaments give rise to the upright, terminal branch-systems. Growth by division of apical cells, and by intercalary cell division lower down. Terminal branches are irregular, wide-angled (45°–90°), with occasional rhizoids from the basal poles of the cells. Filaments of basal and terminal branch-systems sometimes attached to one another by terminal hapteroidal holdfasts at the tips of the apical cells.

Material examined: Four specimens.

Season: Post-monsoon.

Habitat: Found on intertidal sand covered rock, loosely attached to the substratum.

Distribution: Dona Paula, Cabo-de-Rama.

36. ***Rhizoclonium riparium*** (Roth) Harvey Phycol. Brit. t. 238, 1849.

Conferva riparia Roth, Cat. Bot. 216–217, 1806.

Tiresias riparia (Roth) Areschoug, Phyceae Capenses.... 7, 1851.

Rhizoclonium implexum (Dillwyn) Kützing, Phycologia Germanica: 206, 1845.

Rhizoclonium kochianum Kützing, Phycologia Germanica: 206, 1845; Børgesen, Dan. Vidensk. Selsk. Biol. Med. 12: 64, 1935; Chaugule & Gunale, M.V.M. Patrika, 16 (1&2): 5–14, 1981; Krishnamurthy & Joshi, A Checklist of Marine Algae, 36, 1970.

Rhizoclonium kerneri Stockmayer, Verh. K.-K. Zool.-Bot. Ges. Wien 40(Abh.): 582, 1890; Taylor, Marine algae of the eastern tropical and subtropical coasts of the Americas. 870, t. 80, 1960; Krishnamurthy, J. Madras Uni., Sec. B, 24: 161–178, t. 1, f. 16, 1954; Nair *et al.*, Seaweed Res. Util. 12: 125–135, t. 2, f. 9, 1990.

Type locality: Norderney, East Frisian Islands, Germany (*fide* Silva *et al.* 1996).

Diagnosis: Thalli in entangled masses, dark green to pale yellowish green. Uniseriate filaments occasionally twisted, usually with few or none rhizoidal branches, composed of 2–5 cells; filaments 35–50 µm in diameter, 1–3 times longer; reticulate chloroplast with numerous pyrenoids.

Material examined: 15 specimens.

Season: Monsoon.

Habitat: Found on clay banks, upper as well as midtidal zone on rocks and woodwork.

Distribution: Terekhol, Chapora, Anjuna, Reis Magos, Siridao, Palolem, Polem.

37. ***Rhizoclonium tortuosum*** (Dillwyn) Kützing, Phycol. Germ. 205, 1845; Sahoo *et al.*, Seaweeds of the Indian Coast 283, 2001.

Conferva tortuosa Dillwyn, Brit. Conferv.: t. 46, 1805.

Lola tortuosa (Dillwyn) V. Chapman, Proceedings of the Seventh Pacific Science Congress [New Zealand] 5: 65, 1953.

Lola capillaris (Kützing) G. Hamel, Revue Algologique 6: 25–27, f. 37: 1, 1931. Børgesen, Dan. Vidensk.Selsk. Biol. Med. 12: 64, 1935; Chaugule & Gunale, M.V.M. Patrika, 16 (1&2): 5–14, 1981.

Type locality: Swansea, Wales (*fide* Blair 1983).

Diagnosis: Plants forming dull, dark green masses; filaments curled, stiff, 40–70 µm diameter, height of cells is twice its breadth; branches absent. Filaments unbranched, in some cases without but in other material with 1–5 celled lateral rhizoids. Cells 25–40 µm in diameter; cell wall 3–5 µm thick; chloroplast moderately to densely reticulate with numerous pyrenoids.

Material examined: Seven specimens.

Season: Monsoon and Post-monsoon.

Habitat: Found in lower tide pools of exposed shores as dark crisp masses.

Distribution: Terekhol, Vagator, Baga, Siridao, Cabo-de-Rama, Palolem, Polem.

38. ***Cladophoroposis sundanensis*** Reinbold, Nuova Notarisia 16: 147, 1905; Børgesen, Dan. Vidensk. Selsk. Biol. Med. 12: 64, 1935; Krishnamurthy & Joshi, A Checklist of Marine Algae, 36, 1970; Chauhan & Mairh, Salt Res. Ind. 14(2): 21–41, t. 11, f. 5, 1978; Chaugule & Gunale, M.V.M. Patrika, 16 (1&2): 5–14, 1981; Untawale *et al.*, List of marine algae from India, 42, f. 36, 1983; Leliaert & Coppejans, *Phycologia*, 45 (6): 657–679, 2006.

Siphonocladus sundanensis (Reinbold) Reinbold in Weber van Bosse, Siboga Exped. Monogr. 59a: 83, 84, expl. f. 18, 1913.

Type locality: Various in Indonesia (*fide* Silva *et al.* 1996).

Diagnosis: Plants light green, turf forming single axes measuring 15–16 mm in length. Branching widely or closely spaced. Laterals connected to parent cells, arising at wide angles adjacent to the cross walls. Anchoring is done by a series of interwoven prostrate filaments on which numerous 1–3 celled laterals are borne. Basal filaments usually straight, 180–250 µm in diameter. Apical cells (sub) cylindrical, with rounded tip, straight, slightly curved or sinuous. Cells of the terminal branch systems straight or slightly curved, 80–140 µm in diameter.

Material examined: 10 specimens.

Season: Post-monsoon.

Habitat: Found on sand-covered rock substratum in the intertidal zone, exposed to air at low tide, but continuously wave-swept.

Distribution: Terekhol, Dona Paula, Betul, Cabo-de-Rama, Talpona, Polem.

Remark: According to Wynne (2011), this species is a taxonomic synonym of *Cladophoropsis fasciculata* (Kjellman) Wille.

39. ***Boodlea composita*** (Harvey) Brand, Beih. Bot. Centralbl. 18 (Abt. 1): 187–190, 1904; Jha *et al.*, Diversity Distr. Seaweeds Guj. Coast 215, 2009.

Conferva composita Harvey, J. Bot. [Hooker] 1: 157, 1834.

Cladophora composita (Harvey) Kützing, Species algarum: 415, 1849.

Aegagropila composita (Harvey) Brand, Tab. Phycol. 14, t. 67, f. b-d, 1854.

Boodlea siamensis Reinbold, Bot. Tidsskr. 24: 191–192, 1901; Børgesen, J. Indian Bot. Soc. 9: 151–174, f. 10, 1930; Chauhan & Mairh, Salt Res. Ind. 14(2): 21–41, t. 11, f. 5, 1978; Børgesen, J. Indian Bot. Soc. 9: 151–174, f. 10, 1930; Krishnamurthy & Joshi, A Checklist of Marine Algae, 36, 1970; Chaugule *et al.*, Seaweed Res. Util. 11: 107–115. f. 58, 1989; Untawale *et al.*, List of marine algae from India, 42, f. 36, 1983; Jagtap, Ind. J. Mar. Sci. 16: 256–260, t. 1, f. 3, 1987; Jagtap, Indian J. Mar. Sci. 21: 56–58, 1992.

Type locality: Mauritius (*fide* Silva *et al.* 1996).

Diagnosis: Plants rather soft and loose, sponge-like clumps, up to 2 cm tall, consisting of filaments twisted together, branches irregularly divided and becoming somewhat whorled towards the apices, branches irregular in all directions, cells of the main axes 200–350 µm in diameter and 0.8–2 mm long.

Material examined: Seven specimens.

Season: Post-monsoon.

Habitat: Found as spongy mats or as cushion-like tufts, or mixed with other algae on moderately sheltered, horizontal platforms in lower eulittoral subzone.

Distribution: Anjuna, Siridao, Holant, Talpona.

DISCUSSION

Agadi (1986) had reported less diversity of seaweeds along the Goa coast compared to Gujarat and Maharashtra. This was attributed to the strong wave action and smaller intertidal expanse in Goa. Recent studies have reported 209 species of seaweeds along the Gujarat Coast (Jha *et al.* 2009), followed by 159 species from the Maharashtra coast and 75 species from Goa coast (Oza and Zaidi 2000). However, the present study conducted along the Goa coast has revealed a greater algal diversity comprising of 154 species. Maximum diversity of seaweeds was found post-monsoon. Among the newly reported 39 species, 35 were collected post-monsoon. Two species belonging to *Porphyra* were found to be exclusively confined to the monsoon season. Two species of *Rhizoclonium* were found during the monsoon and sporadically during post-monsoon. Pre-monsoon was observed to be the least suitable season for algal growth; only one species – *Padina australis* – was collected during this period. Our work corroborates earlier studies on seasonal distribution of marine algae along Indian shores that reveal maximum seaweed growth during December to February (Untawale *et al.* 1989).

All these species have been found to occur along the Indian coast with some of them being reported from neighbouring regions like the Konkan belt, as well as Mumbai coast. The algal species found along the west coast of India are known to harbour several cosmopolitan taxa such as *Ulva lactuca*, *Rosenvingea intricata* and *Caulerpa* sp., among others, which are found to occur in both tropical and temperate regions (Srinivasan 1960). The species composition of algae along the west coast of India reflects similarities with the tropical flora (Agadi 1986). Some species that were earlier recorded from the east coast or Andaman and Nicobar Islands, have been found to occur along the Goa coast in this study. The occurrence of these species in Goa can possibly be explained through the phenomenon of migration.

The seaweeds found along the Goa coast have been mentioned in marine algal checklists of India (Oza and Zaidi 2000; Sahoo *et al.* 2001). Of the 39 species reported here, two species namely, *Erythroglossum lusitanicum* and *Cladophora prehendens* have not been reported from India before (Sahoo *et al.* 2001). It has been observed earlier that the benthic marine algal flora of Indian shore is cosmopolitan, with several of its species occurring in both tropical and temperate areas (Srinivasan 1960).

Cladophora prehendens has been reported from Australia (Kraft 2007; Womersley 1984) while *E. lusitanicum* has been reported from the Atlantic Ocean and Mediterranean Sea. Phytogeographically, Asia, Europe, and Australia may have similar flora, but recent additions in the algal flora along the Indian coastline could be explained by the phenomenon of floral migration aided by shipping activities, with the help of wave action wherein spores get carried from one coast to another. Dispersal of algae can be aided by transportation activities in the sea wherein the ballast water becomes a carrier for several algal and dinoflagellate spores.

This study has revealed presence of species that were earlier not reported from the Goa coast and the absence of certain species that were earlier found in Goa. A detailed survey of the Indian coast will help to gain insights into the nation's marine biodiversity.

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REVIEWS

NATURE CHRONICLES OF INDIA: ESSAYS ON WILDLIFE edited by Ananda Banerjee. Published by Rupa Publications India Pvt. Ltd, New Delhi. Size: 21.5 cm x 13 cm. 159 pp. Price: ₹ 195/-. Paperback.

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Despite the presence of spectacular wildlife and increasing number of wildlife researchers, there are very few good wildlife writers in India who can chronicle natural history. Nature magazines like *Hornbill*, *Sanctuary*, and *Saevus* publish short pictorial articles, not essays.

Ananda Banerjee has done us a remarkable favour by bringing out an eminently readable book containing wildlife essays written by some of the most prominent young and not-so-young wildlife scientists of India. The book is divided into two parts: contemporary articles and archival material, which complement each other. The tone of the book is set by Jay Mazoomdaar's essay on community conservation work for the protection of Olive Ridley turtles, followed by Krupakar-Senani's wonderful piece on Wild Dogs. *My First Days in the Field* by Rauf Ali and *Lunch with the Snow Leopard* by Yash Veer Bhatnagar are delights to read, mainly due to the fact that the articles are firsthand experiences written with passion and wonderment that nature bestows on all of us if we go to her. My favourite is by Madhusudan Katti *Are Warblers Less Important than Tigers*? I think this is the essay that should be read by every Indian conservationist and decision maker. It is a very fine piece of research showing how warblers – perhaps the most difficult group of birds to identify – despite their small size and unobtrusive living, eat a huge amount of insects and keep our forests healthy.

The second section of the book consists of diverse stories by seven British wildlife writers of the past. As Banerjee has written "These writings … will transport you to the forests and landscape of yore. These are interesting records of the forest and lives of people in British India. The stories tell us about a flourishing wildlife, jungle packed with wild animals, and backyards and kitchen gardens teeming with common species." Sadly, those days are gone but perhaps with more books like this, greater interest will be created amongst the general public to enjoy, write, preserve, and protect India's wildlife and wild places.

At Rs. 195/- (less than the price of a pizza in a mall!), it is a nice buy and a good gift for friends interested in nature. The front cover is adorned with an intense looking Snow Leopard by Dhritiman Mukherjee and the back cover has the image of a warbler by the author, precariously balanced on a thin branch – the juxtaposition of these two contrasting taxa brings home the point that both these species are equally important. I recommend this book to all who care for wildlife.

■ ASAD R. RAHMANI

■ ■ ■

MISCELLANEOUS NOTES

1. A FURTHER RECORD OF LARGE INDIAN CIVET *VIVERRA ZIBETHA* LINNAEUS 1758 FROM ODISHA, INDIA

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Acharjyo and Patnaik (1987) reported occurrence of the Large Indian Civet *Viverra zibetha* from Odisha in Phulnakhara, Cuttack district, and thereafter another specimen was collected from Satpada (Saha 1995). On June 23, 2010, during a field trip to Hindol area of Dhenkanal district (20° 30' N; 85° 15.10' E), a male was spotted by us at 19:30 hrs, crossing a forest road. The animal was observed from a distance of about 5 m for about 2 or 3 seconds, after which it disappeared into a thicket. It was of the size of a medium-sized dog in height, had a curved back with a mid-dorsal crest of long fur, short legs, and a long bushy tail. From these features, and from the prominent black bands on the whitish tail, it was identified as the Large Indian Civet. The animal was too large to be the Small Indian Civet *Viverricula indica*, which is commonly seen crossing roads at night.

The Large Indian Civet is known to occur in northeast India and Upper Bengal, and elsewhere in Southeast Asia (Prater 1965), and now Odisha appears to be the southernmost distribution limit of the species. It is protected under Schedule I of the Wildlife (Protection) Act, 1972, and is listed as Near Threatened in IUCN Red List (assessed during June, 2012). Since there are now a few records of the species from Odisha, a systematic survey in the protected and non-protected areas of the state is urgently needed to know the exact status, which may help in preventing the species from becoming locally extinct.

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2. MONGOOSE RABIES IN KANNUR, KERALA, INDIA

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The Indian Grey Mongoose *Herpestes edwardsi* is distributed almost throughout India (Prater 1965). It feeds on small mammals, birds, reptiles, fruits, eggs, and invertebrates; lives in burrows and breeds throughout the year (Prater 1965). Mongoose species are known to be vectors of the rabies virus (Rhabdoviridae) (Rabies Survey Report 2003). Though the occurrence of mongoose transmitted rabies has been reported from various countries, the occurrence of dog rabies has masked its importance (Everard and Everard 1988). The outbreak of rabies through Asian Mongoose *Herpestes javanicus* in Puerto Rico led to secondary transmission to dogs and other animals (Tierkel *et al*. 1952). Other species of Herpestidae like Yellow Mongoose *Cynictis penicillata*, Suricate *Suricata suricatta*, Small Grey Mongoose *Myonax pulverulentus*, and Genet Cat *Geneta felina* are reported to be important vectors of rabies virus in South Africa (Neitz and Marais 1932; Snyman 1940; Snyman and Thomas 1938).

Although the Indian Grey Mongoose is listed as a rabies virus vector in India, the Golden Jackal *Canis aureus* is known to be the principal wild species which transmits the virus (Fagan 1950). In Bangladesh, eight cases of human rabies due to mongoose-bite were reported (Rahman *et al.*

2007). Human rabies in northern India was studied by Ratho *et al.* (2001), reporting one case of death by the bite of a rabid mongoose. In a survey of incidence of rabies among wild animals, 92 cases of mongoose rabies were confirmed from wildlife parks and zoos in India (Rabies Survey Report 2003).

In this communication, we report cases of rabid mongoose in Edakkad, Kannur District, Kerala, based on data collected during our visits on June 18, 2010. This is the first report from India on a massive attack of rabid mongooses on humans in a village, and for which compensation was given by the Kerala Forest and Wildlife Department. There have been 21 cases of attacks on humans by rabid mongoose at Edakkad from March 2010 to June 2010. We visited the houses of two victims, Imtiyas (10, boy) and Shahana Sherin (9, girl). The boy had been bitten on the cheek, and the girl on the thigh. The locals said that mongooses were sighted frequently during that period in large numbers, approaching and attacking people without any provocation. Most of the bites were on legs. The increase in the numbers of mongoose and subsequent death of the animals were noticed by them and brought to the attention of the Forest Department. On post-mortem examination of the animals, rabies symptoms were detected. Some incidents of rabid mongoose attacking people were also reported in May 2009.

The Department took initiatives to make the locals aware of the rabies threat and provided assistance for anti-rabies vaccination. The compensation details available with the Thaliparamba Forest Range Office, Kannur Forest Division, revealed that 21 victims (43% female and 57% male) applied for compensation. A total amount of Rs. 77,000/- (rupees seventy seven thousand only) was claimed by the victims, and an amount of Rs. 30,375/- (rupees thirty thousand three hundred and seventy-five only) towards compensation was disbursed.

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3. FIRST RECORD OF INDIAN LONG-EARED HEDGEHOG *HEMIECHINUS COLLARIS* FROM DHAULPUR, EASTERN RAJASTHAN, INDIA

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Dhaulpur (=Dholpur) (26° 41' 59" N; 77° 54' 00" E; 177 m above msl) lies in the eastern corner of Rajasthan. It is known for its ravines extending all over the catchment of the Chambal river. The river and its banks are part of National Chambal Sanctuary and harbour some of the most endangered mammalian, avian, and reptilian fauna like the Ganges Dolphin *Platanista gangetica*, Indian Skimmer *Rynchops albicollis*, Black-bellied Tern *Sterna acuticauda*, River Tern *Sterna aurantia*, River Lapwing *Vanellus duvaucelii*, Gharial *Gavialis gangeticus*, Marsh Crocodile *Crocodylus palustris*, and many species of endangered turtles.

The first author had sightings of the Indian Long-eared Hedgehog *Hemiechinus collaris* in agricultural fields on the outskirts of Dhaulpur city for three years, and in 2013, brought it to the notice of the second author during his visit to Dhaulpur, after which we realized that this species is not reported to be as common as the Pale Hedgehog *Paraechinus micropus* in eastern Rajasthan (Prater 1988). The Indian Long-eared Hedgehog can be easily differentiated from the Pale Hedgehog by the long ears and absence of parting spines running from forehead to crown.

Two species of hedgehogs occur within Indian limits, namely Long-eared Hedgehog *Hemiechinus auritus* with subspecies *collaris* (Gray) and Pale Hedgehog *Paraechinus micropus* with subspecies *micropus* (Blyth) and *nudiventris* (Horsfield) (Prater 1988). Prater (1988) states that hedgehogs are mainly confined to the dry desert zone of Kachchh, Sindh, Punjab, and the former NWFP and neighbouring tracts; *P. m. nudiventris* is confined to the plains of southern India. The C.A.M.P. report (Molur *et al*. 2005), with collated data from various sources on the distribution and status of small mammals in India, states the distribution of Long-eared Hedgehog in the arid western parts of Rajasthan and Gujarat. The IUCN Red List of Threatened Species (Molur 2008) states that it is distributed in the western part of India in Desert National Park in Rajasthan and Narayan Sarovar Sanctuary in Gujarat.

In the distributional map of the species in The IUCN Red List of Threatened Species, Version 2014.2. <www.iucnredlist.org>, a very limited area of central Uttar Pradesh in Doab area of Ganges (= Ganga) and Yamuna river is shown as the area of its occurrence. In a recent publication, Singh *et al*. (2013) report its presence in Thar, Aravalli, and southeast Rajasthan (south-east Rajasthan here referring to the area east of the Aravalli range in the districts of Bhilwara, Rajsamand, and southern part of Ajmer district).

Himmat Singh (pers. comm.), who worked on the non-volant small mammals of Rajasthan after Singh *et al*. (2013), recorded it at the foothills of Alwar in east Rajasthan, which is *c*. 200 km to the west of Dhaulpur, but this report has not been published. Our sightings at Dhaulpur reconfirm the presence of Indian Long-eared Hedgehog from north-eastern Rajasthan, and this is also the first report of its occurrence in Dhaulpur. It was found to be a common species there, living in burrows amidst crop fields. It was more frequently sighted after the harvest, during which road-kills involving it were also recorded. Its vocalization is not reported in literature, but we heard it making wailing noises resembling those of a human baby. It seems possible that this species that frequents various habitats is more common in the northern part of central India than previously assumed.

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4. OBSERVATIONS OF MASTURBATION AND CONSUMPTION OF EJACULATE BY FIVE-STRIPED PALM SQUIRREL *FUNAMBULUS PENNANTII*

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Introduction

The Five-striped Palm Squirrel *Funambulus pennantii* is a small rodent, distributed in the Indian peninsula from the base of Himalaya till the northern parts of southern India, and its flexibility to habitat requirement makes it one of the most common mammals adapting to urban landscapes in India (Prater 1988). In this communication, I report on 40 observations of masturbation and consumption of ejaculate by an individual squirrel recorded during a five month period in Ahmedabad, Gujarat.

The site of observation was on a Neem *Azadirachta indica* tree, which was frequented by three adult squirrels, a female and two males; the masturbations observed were by the smaller male. The first observation was at 7:00 hrs in late October 2013, after which the individual was monitored 7–10 times a month. During these observation bouts

(07:00–07:40 hrs), the individual was seen lying motionless and basking in the sun till the weather warmed up. Then, the process of grooming commenced with pandiculation (stretching and yawning), licking and cleaning of body parts, cleaning the paws and nails, then tail, which was followed by masturbation with simultaneous consumption of the ejaculate. The squirrel used the same place for grooming during my observations till March 2014.

Each time this activity was observed, the squirrel was seen to be alone, and the presence of any other squirrel was not seen during the act. It was occasionally seen engaged in grooming with the female. The skittering call of the species was commonly heard during the observations, but not being made by the masturbating individual. The observed squirrel was seen being chased by the other male on three occasions. No act of copulation between the other squirrels was seen during the observations, which was also the case of squirrels on other trees in the vicinity. Around 150 photographs of grooming and social grooming were taken during the study.

Masturbation with consumption of ejaculate has been reported in the promiscuous Cape Ground Squirrel *Xerus inauris* by Waterman (2010), and extracts of the findings are quoted here "... masturbation to be far more frequent on days of female oestrus and mostly occurred after copulation. Masturbation rates were higher in dominant males, which copulate more, than in subordinates and increased with number of mates a female accepts. These results suggest that masturbation in this species was not a response to sperm competition nor a sexual outlet by subordinates that did not copulate. Instead masturbation could function as a form of genital grooming. Female Cape ground squirrels mate with up to 10 males in a 3-hr oestrus, and by masturbating after copulation males could reduce the chance of infection."

In my observations, masturbation was done by a smaller, subordinate male and appeared to be a sexual outlet or a form of genital grooming, as it was never recorded copulating with the female in the area. Since squirrels are territorial and this was the younger male, I wonder whether consuming the ejaculate could be a process for removing scent mark from the location to prevent territorial fights – semen is also rich in protein.

On reporting my observations to Jane Waterman, she commented "I am not surprised to hear about another squirrel masturbating but it is really cool to know of another species. I suspect it occurs in a number of species that breed throughout the year. There is a tree squirrel in southern Africa that has been described as 'grooming' in a way that is obviously masturbation." In another personal communication, she comments: "I see that in this species females mate with multiple males and that breeding can occur year round. Indeed, I suspect that males may have to contend with sexually transmitted infections. In other words, the behaviour could be a thorough way to groom. Masturbation has not been described for this species. You only have a single individual, so it is hard to say whether the behaviour is common or not. "

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5. THE MALAYAN NIGHT-HERON *GORSACHIUS MELANOLOPHUS* IN MOUNT HARRIET NATIONAL PARK, ANDAMAN ISLANDS

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The Malayan Night-Heron *Gorsachius melanolophus* is one of the peculiar, discontinuously distributed Indo-Malayan species of evergreen biotope found in the Indian subcontinent. It occurs as a summer visitor to Assam and Manipur, migrating through Meghalaya and Mizoram. It is partly resident in the Western Ghats, some migrating to Sri Lanka and resident to central and south Nicobar Islands (Ali and Ripley 1978; Rasmussen and Anderton 2012). It is represented by two subspecies within Indian limits of which *G. m. minor* Hachisuka is endemic in the Nicobar group of islands, which differs from the nominate subspecies *G. m. melanolophus* Raffles in being smaller (Ali and Ripley 1978; Tikader 1984).

On February 24, 2011, in the morning while walking from the forest rest house in Mount Harriet National Park, Andaman Islands, I saw a Malayan Night-Heron close to the road near the abandoned Chief Commissioner's Bungalow. Moving slowly, I was able to get quite close to the bird and observe it. On noticing my presence, it slipped into the dense forest.

Ali and Ripley (1978) and Tikader (1984) describe its habitat as streams and swampy patches in thick forest, but the place I sighted it had no swamp or stream; although the forest was dense. The species is "scarce (or overlooked)" in Andamans (Rasmussen and Anderton 2012). The sighting of the species in Mount Harriet National Park, where there are no previous records, indicates that it could be resident in the Andamans, as it is in the Nicobar Islands.

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6. FIRST RECORD OF GREATER WHITE-FRONTED GOOSE *ANSER ALBIFRONS* (SCOPOLI, 1769) AMRAVATI, MAHARASHTRA, INDIA

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The Greater White-fronted Goose *Anser albifrons* is a winter visitor to Nepal, NW India, and Bangladesh in vagrant category and has not been recorded in Maharashtra (Grimmett *et al*. 2009; Kazmierczak and Van Perlo 2012; Sinclair 1886). On January 20, 2014, we visited Kekatpur (21° 5′ 36.7″ N; 77° 57′ 7.4″ E), district Amravati, Maharashtra, often referred to as a "birder's paradise". As the first author (AK) clicked photographs of birds in the wetland, he noticed a bird (Ed.: photographic evidence provided) that was slightly larger than the Ruddy Shelduck *Tadorna ferruginea* it was foraging with. After hearing alarm calls of a Black-naped Ibis *Pseudibis papillosa*, both the shelducks and goose were alerted and flew off; the goose uttering high nasal calls of *gaanng-gaanng-gaang*. Manoj initially wrongly identified it as the Greylag Goose *Anser anser*, which was last sighted by Raju Kasambe at Warud in 1993 (Kasambe *et al*. 2007).

On a closer look at the photographs, we observed that the bird had long bright orange legs, a brownish-grey body, belly with slightly black splotches, and black tail with a white band at the tip, matching the Greater White-fronted Goose (Grimmett *et al*. 2009). The identification was confirmed by Ragoo Rao (India Nature Watch), Mysore and Raju Kasambe (BNHS India). After a week, the bird was sighted again by Jayant Wadatkar and team (Jayant Wadatkar pers. comm.), in the same place. This is the first record for the species from Amravati, Maharashtra, in central India (Kasambe *et al*. 2007; Khan 2014; Mahajan *et al*. 2012; Pachlore and Chandrakar 2011).

In recent years, there have been a number of records of the Greater White-fronted Goose by birdwatchers at some new sites in India, which are summarized in Table 1.

Table 1: Recent sighting records of *Anser albifrons* in India

Sr. No.	Name of birder	Location	Date	Source	No. of birds
1.	Avijan Saha	Fulbari barrage, Siliguri, West Bengal	Jan. 27, 2013	www.indianaturewatch.net	1
2.	Tejus Naik and Rakesh	Dighal, Jhaggar, Haryana	Nov. 13, 2013	pers. comm.	1
3.	Kannan Achi Sundararajan	Little Rann of Kachchh, Gujarat	Dec. 24, 2013	Oriental Bird Club	4
4.	Mansur Ahmad	Koonthankulam Bird Sanctuary, Tirunelveli, Tamil Nadu	Dec. 28, 2013	pers. comm.	2

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7. FIRST REPORT OF LONG-BILLED PLOVER *CHARADRIUS PLACIDUS* FROM MAHARASHTRA, CENTRAL INDIA

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Long-billed Plover *Charadrius placidus* is a winter visitor to NE India from Nepal and north Uttar Pradesh to Assam valley and Manipur; there are a few sight reports from Bangladesh, Delhi, Andaman Is., and Sri Lanka. It breeds in NE Asia to SW China (Rasmussen and Anderton 2012). It is also reported in Arunachal Pradesh (Greeshma 2011) and breeds in Sangti Valley of western Arunachal Pradesh (Eaton and Rheindt 2009).

During our study on summer breeding birds and passage migrants, on April 06, 2014, we visited Kekatpur reservoir (21° 05′ 28″ N; 77° 57′ 15″ E), Amravati district, Maharashtra, and sighted the Black-tailed Godwit *Limosa limosa*, Wood Sandpiper *Tringa glareola*, Common Sandpiper *Actitis hypoleucos*, and Little Ringed Plover *Charadrius dubius* feeding in the shallows. A bird in the flock of Little Ringed Plover *Charadrius dubius* attracted our attention, as it was being mobbed by them. The bird, however, tried to stay with the flock. On checking through binoculars, we noted that the bird was bigger than the Little Ringed Plovers, and photographed it. Later, with the help of field guides we identified it as the Long-billed Plover *Charadrius placidus*. The bird stayed in the area for the next three days.

On literature survey, we found that this is the first sighting of the species from Maharashtra (Abdulali 1981; Ali and Ripley 1983; Rahmani *et al.* 2013).

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8. SIGHTING OF A FLOCK OF LEUCISTIC BLACK-TAILED GODWIT *LIMOSA LIMOSA* IN CHILIKA LAKE, ODISHA, INDIA

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Chilika (19° 43′ N; 85° 19′ E; 1,165 sq. km), Odisha is one of the major wintering grounds for waterbirds along the east coast of India (Balachandran *et al*. 2005; Dev 1988; Kar and Sahu 1993). Chilika is an estuarine lagoon, shallow throughout its spread, and connected to the Bay of Bengal. It receives water from Rivers Daya and Bhargavi, and several small streams. Several islands are located in the lagoon covering an area of 22,300 ha (http://www.chilika.com/ Accessed February 8, 2012). Mangalajodi, a village on the banks of the lagoon, witnessed a successful initiative by Wild Orissa (http://wildorissa.org/ Accessed February 8, 2012) to prevent poaching of waterfowl by involving former poachers/hunters as their protectors (Nayak 2012; Pathak 2009).

During a monitoring trip for waterbirds on January 22, 2012, in the Mangalajodi area, we sighted a flock of six whitish birds on the shore that resembled the Black-tailed Godwit *Limosa limosa* except for the coloration; some birds had pale buff markings. The birds were foraging in a grassy patch a few metres from a flock of 4,000+ Black-tailed Godwit. The godwits were seen occasionally chasing the whitish birds. The birds were again observed during subsequent visits to the area, during which six or less birds were observed. The birds were photographed by Mr. Nanda Kishore Bhujabal (Fig. 1).

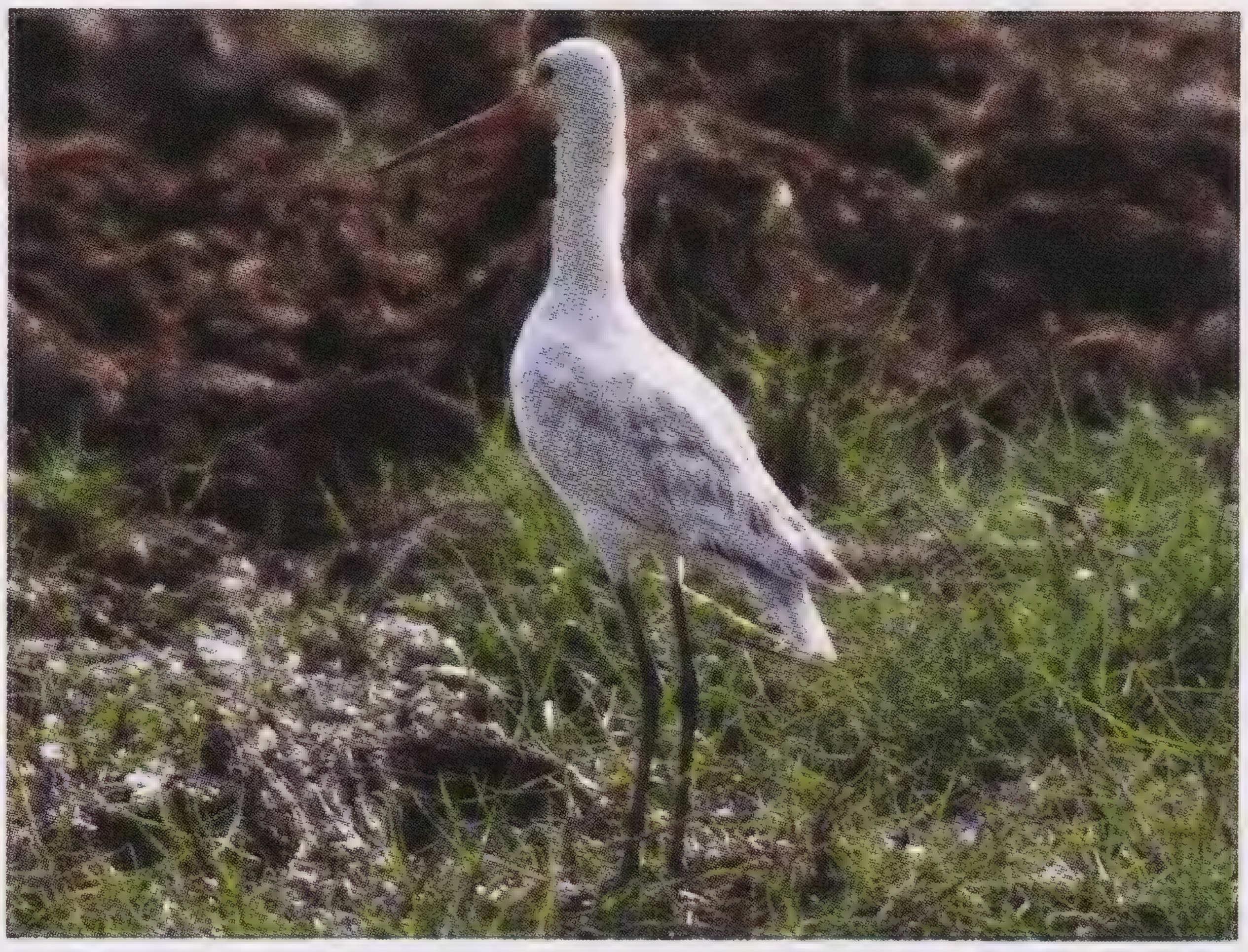

Fig. 1: Leucistic Black-tailed Godwit sighted at Chilika Lake

In the field, the birds did show the presence/signs of the black tail-band that is distinctive in the Black-tailed Godwit, but one of the photographs examined later on showed that one had a band on the underside of the tail. This feature and the black (*vs*. pink) eyes seen in the photograph suggest that the birds were leucistic individuals, rather than albinos. Instance of leucism/abinism has been reported for many species in the wild, but our sighting is interesting as besides probably being the first report for the Black-tailed Godwit, six birds were seen together in a flock.

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9. RECORDS OF IBISBILL *IBIDORHYNCHA STRUTHERSII* IN THE BHAGIRATHI RIVER, HARSIL, UTTARAKHAND, INDIA

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Ibisbill *Ibidorhyncha struthersii* has long been an enigma on account of its rarity, elusive behaviour, and specialized niche requirement. It is a good swimmer and feeds on aquatic invertebrates by probing underneath rocks and gravel in shingle beds of fast-flowing streams (Pierce 1986). Its evolutionary status is not well-established though it appears to be most closely related to oystercatchers, avocets, stilts, and *Pluvialis* plovers (Baker *et al*. 2007). However, because of its unique and distinctive features, and absence of subspecies (Sibley and Monroe 1990), it has been placed in a family of its own, Ibidorhynchidae.

The global population of this species is largely unknown. The population estimate for China mentions about 100 breeding pairs (Brazil 2009). Even though the IUCN conservation status of the species is Least Concern (BirdLife International 2012), its distribution in India is restricted to a few places in the Himalaya and records of sightings have been invariably very rare (Grimmett *et al*. 2011).

BirdLife International describes the breeding range of this bird between south-eastern Kazakhstan and northern China, touching the north-western tip of the Himalayan range in India. The range spans across Ladakh, Jammu and Kashmir, some places in Uttarakhand and a few sites in north-east India (Grimmett *et al*. 2011). Early records of sightings in India date back to 1906 (Whymper 1906) and 1910 (Whymper 1910) in the upper Bhagirathi in Uttarakhand and in 1935 (Stanford 1935) in upper Burma (now Myanmar). Recent records are from Kosi river, Ramnagar, Jim Corbett National Park in Nainital district, Uttarakhand, and Jia Bhorali river in Nameri National Park in Assam. Ideal habitats of the species comprise shingle-bed river valleys between 1,700 m and 4,400 m above msl with intermittent stretches of sand and silt, boulders, cobbles, and pebbles (Ye *et al*. 2013).

As part of an on-going study of riverine forests and birds along the River Ganga in the Bhagirathi catchment area, field surveys are being carried along the banks of the Bhagirathi river at regular intervals by us. During this survey, Ibisbills were spotted thrice at an elevation of about 2,500 m above msl. In October 2013, two adults and two subadults were spotted feeding from shingle beds near Bagori village in the Harsil valley (31° 02′ 19.93″ N; 78° 44′ 14.17″ E). In March 2014, two adults were seen feeding in the same locality. An adult with two chicks were spotted towards the end of May 2014, on a pebble and sand island in the middle of several streams around the same site. Harsil is a broad valley on the banks of Bhagirathi, with moderately flowing braided streams and pebbled sandy banks, at an altitude of 2,500 m above msl in Uttarkashi district, Uttarakhand, which appears to be ideal habitat for the species. During all the observations the birds were well-camouflaged because of their greyish plumage. However, their long, curved, red bill and prominent black band at the neck made them visible amongst the grey pebbles and sand. They were feeding voraciously by probing under the rocks, gravel, and water collected in between small boulders.

Ibisbills were reported breeding in this area almost a century ago (Whymper 1910). The sightings of birds in different seasons of the year during our study confirm that Harsil is still a potential breeding ground for these birds. The general information obtained so far indicates that the species breeds in the trans-Himalayan region and migrates to lower elevations during the non-breeding season. Further monitoring of birds in Harsil could reveal interesting facts about this bird's breeding behaviour.

Factors such as climate change, geographical and altitudinal shifts in habitat suitability, and pressures on riverine habitat from tourism, infrastructure development and waste disposal, could affect this riverine specialist (Buckton and Ormerod 2002). Given that little is known about the ecology and other aspects of the species, and that the river systems are undergoing adverse climatic change and anthropogenic impacts in India, these sightings are significant and call for concerted monitoring strategies to understand the conservation status of the bird.

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10. MOUNTAIN IMPERIAL-PIGEON *DUCULA BADIA* (RAFFLES) FEEDING ON *CAESALPINIA PULCHERRIMA* (FABACEAE) FLOWER BUDS

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Jawaharlal Nehru Tropical Botanic Garden and Research Institute (8º 45′–8º 47′ N; 77º 1′–77º 4′ E; 120 ha) is situated at the foothills of the southern Western Ghats, Thiruvananthapuram district, Kerala. A study on bird diversity of the garden initiated in 2011 revealed the presence of 135 species till April 2014. During the studies, a flock of eight Mountain Imperial-Pigeon *Ducula badia* (Raffles) was sighted in the campus from June 2013 onwards. On July 26, 2013, afternoon, a bird was sighted flying and perching on a small flowering shrub of *Caesalpinia pulcherrima* (Fabaceae). *C. pulcherrima* is an exotic that has been introduced throughout the world as an ornamental plant (Dassanayake and Fosberg 1991). The bird first sat near an inflorescence in the lower branch and started feeding on the flower buds. The feeding process was slow and about six buds were consumed within 15 minutes. It took only the buds, even though the stalk had six open flowers and two pods. Then the bird moved to the upper part of the plant with an inflorescence consisting of three opened flowers and 13 buds. Here too, it took only the buds and not the open flowers.

The Mountain Imperial-Pigeon occurs in the rainforests of the Western Ghats and E. Himalaya from Arunachal to Nepal up to *c.* 2,300 m and NE hill states (Ali and Ripley 1987; Manakadan *et al.* 2011). They are highly arboreal and frugivorous, consuming especially fruits of banyan and other wild figs and nutmeg (Ali and Ripley 1987). My observation on the species feeding on the flower buds is interesting, as the only other such record from India is on the flower buds of *Avicennia officinalis* L. in mangroves of Kannur district, Kerala (Jerdon 1846). However, this species has been reported to feed occasionally on buds and young leaves in other countries of its range (del Hoyo *et al.* 1997).

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11. FIRST REPORT OF FOREST OWLET *HETEROGLAUX BLEWITTI* FROM TANSA WILDLIFE SANCTUARY (WESTERN GHATS), MAHARASHTRA, INDIA

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The Forest Owlet *Heteroglaux blewitti* was considered extinct for 113 years, until its rediscovery in November 1997 in the Toranmal Reserve Forest of Shahada, Nandurbar district, Maharashtra (King and Rasmussen 1998). Subsequent surveys reported its occurrence from Taloda Reserve Forest (Ishtiaq and Rahmani 2000), Nandurbar district; Yawal (Chavan and Rithe 2009), Jalgaon district; Melghat (Ishtiaq and Rahmani 2000; Jathar and Rahmani 2004; Mehta *et al*. 2008), Amaravati district; Narnala (Chavan *et al*. 2013) Akola district; Khaknar (Ishtiaq and Rahmani 2000; Mehta *et al*. 2008) Burhanpur district; and Piplod, East Kalibhit and West Kalibhit forest ranges (Mehta *et al*. 2008) in Khandwa district, Madhya Pradesh. Historically, the species was known from Phuljhar in Chhattisgarh, Sambalpur in Odisha (earlier Orissa), and Taloda and Shahada in Maharashtra (Rasmussen and Collar 1999). All these past and present records are from Satpuda mountain ranges, and the species has not been recorded south of Tapti river. In this communication, we report its occurrence in Tansa Wildlife Sanctuary (19° 45′ N; 73° 20′ E), which partly lies in the northern Western Ghats region in Maharashtra.

On October 24, 2014, during a field survey of birds in and around the periphery of Tansa Wildlife Sanctuary (Tansa), we observed an owlet perched in a dry tree at 10:56 hrs. It was unusual to see an owlet perched in the open during the day. We observed that it differed from the Spotted Owlet *Athene brama* in having an unspotted crown, complete collar on the breast, dark primaries, and a broadly banded tail. We managed to take one clear photograph before the bird flew off. Later, we confirmed the identification with Dr. Girish Jathar, who had worked on the species. The habitat adjoining the area was dry deciduous forest with open patches, which is the typical habitat of the species (Ishtiaq and Rahmani 2000; Jathar and Rahmani 2004, 2011). The area is slightly degraded due to encroachments and human disturbances. Subsequent to this sighting in Palghar district, we also recorded the species in November 2014, in the adjoining areas of Tansa Wildlife Sanctuary in Thane district, *c*. 20 km from our first location.

Our observation reveals the occurrence of the Forest Owlet in the Western Ghats for the first time, and this site is *c*. 250 km southwest of Taloda in Nandurbar, its nearest known distribution site. The discovery of the species in Tansa and adjoining forests of Thane and Palghar districts calls for reassessment of the distribution of the species, especially in areas with similar habitat other than those historically known.

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12. UNUSUAL CONGREGATION OF SAVANNA NIGHTJAR *CAPRIMULGUS AFFINIS* IN A WHEAT FIELD

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On February 15, 2012, we were at Partala (22° 49′ 4.56″ N; 80° 18′ 33.83″ E), initiating People's Biodiversity Register. Partala is situated in Narayanganj tehsil of Mandla district in Madhya Pradesh. The village is surrounded by forested hills on three sides, and a small river flows amidst them. The river banks are surrounded by agricultural fields with scattered trees. The main crops are paddy, wheat, maize, and various pulses. The dominant vegetation in this region is *Tectona grandis*, *Terminalia arjuna*, *Aegle marmelos*, *Soymida febrifuga*, *Madhuca indica*, *Ficus religiosa*, and *Butea monosperma*.

At 18:15 hrs we reached a huge Peepal tree *Ficus religiosa*, which is one of the roosting sites of the Yellow-footed Green-pigeon *Treron phoenicoptera*. On reaching, we heard a cacophony of nightjar calls from an adjacent field. It was getting dark and we could only see silhouettes of the nightjars flying erratically, crisscrossing each other above the wheat field. There were around 30–35 birds, continuously calling and sallying on swarms of insects (moths). We identified them as Savanna Nightjar *Caprimulgus affinis* based on their distinct *cweetzz*, *cweetzz*, *cweetzz* calls. Along with nightjars, small insectivorous bats were also observed feasting on the moths. Two more species of nightjars, namely Indian Jungle Nightjar *Caprimulgus indicus* and Indian Little Nightjar *Caprimulgus asiaticus*, are found in this region. However, we could not hear the calls of these species to ascertain their presence in the congregation. The nightjars were scattered across the wheat field, and since visibility was extremely poor, we could not take photographs. We observed this congregation for almost half an hour, after which we could not follow their movements due to nightfall.

Ali and Ripley (1983) indicate that the Savanna Nightjar forms loose flocks of 7 or 8 while undertaking local movements. Similarly, Rasmussen and Anderton (2005) also state that Savanna Nightjars 'often fly in groups'. These anecdotes suggest the gregarious tendency of Savanna Nightjars. However, large congregations of Savanna Nightjars, as recorded by us, have not been published. A similar observation was made by P. Jeganathan (*pers. comm.*) in Sri Lankamalleshwara Sanctuary, Andhra Pradesh, on June 16, 2001. He observed 15 individuals, probably of Indian Little Nightjar *Caprimulgus asiaticus*, near an agricultural field foraging on insects. The European Nightjar *Caprimulgus europaeus* is known to form loose parties or flocks of 6 to 20 individuals on their passage to autumn migration (Ali and Ripley 1983).

The only known gregarious species of nightjar is the Sand-colored Nighthawk *Chordeiles rupestris* of South America, with flocks of up to 50 individuals observed (del Hoyo *et al.* 1999). Del Hoyo *et al.* (1999) also mention that during migration and in the non-breeding season, more than one species of nightjar join to form groups of more than 20 birds, gathering at good food resources, such as grazing animals, animal corrals, lights or fires, or at insect swarms or termite emergence. Some species of nighthawk, such as Common Nighthawk *Chordeiles minor* and Lesser Nighthawk *Chordeiles acutipennis*, often forage in large flocks of several hundred birds.

On February 16, 2012, we collected some moths which were identified as *Helicoverpa* sp., a common pest on wheat. King (1994) mentions that "Adult moths emerge from just after dark to midnight and crawl onto a plant or vertical substrate where their wings dry". Williams *et al.* (2011) mentions that "Night birds such as the Tawny Frogmouth and nightjars feed on *Helicoverpa* moths as they are also active at night." These probably explain the reason for the large congregation of Savanna Nightjars sighted by us at Partala. It is very likely that such assemblages are common in this region. However, this needs further investigation.

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13. INDIAN SPINY-TAILED LIZARD *SAARA HARDWICKII* IN SARISKA TIGER RESERVE, NORTH-EASTERN RAJASTHAN, INDIA

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The Indian Spiny-tailed Lizard *Saara hardwickii* is endemic to the dry areas of north-western Indian subcontinent (Daniel 2002; Das 2002), and has a patchy distribution throughout its range. While largely herbivorous, it occasionally feeds on insects during the summer (Dutta and Jhala 2007). It is solitary; adult lizards excavate burrows generally 6–8 cm wide and 2 m long. Therefore, active burrows surrogate the number of individuals, and can be used to estimate population density (Dutta and Jhala 2007). In India, it is known to occur in small isolated patches in the Thar Desert and surrounding semi-arid regions of Rajasthan, Gujarat, and western Uttar Pradesh. In Rajasthan, it is known to occur in the Thar Desert, which extends through the westernmost districts of Jaisalmer, Barmer, Jodhpur, Bikaner, and Sri Ganganagar. Apart from Thar Desert, it was only known to occur in the Tal Chhapar Wildlife Sanctuary, which is situated in Churu district, adjacent to Bikaner district (Das *et al.* 2012), classified under biogeographic zone 3A-Thar Desert (Rodgers *et al.* 2002).

Perhaps the most serious threat to the Indian Spiny-tailed Lizard population is habitat loss, brought about by developmental activities, such as agriculture (expansion of farmlands and irrigated areas), industries, and urbanization (housing) in western Rajasthan (Ramesh and Ishwar 2008) and Kachchh, Gujarat (Patel 2011). These lizards are hunted for their flesh as a protein substitute and oil extracted from their skin and tail is considered aphrodisiac. Due to limited data on its distribution, status, and ecology, Spiny-tailed Lizard is considered as Data Deficient in India (Molur and Walker 1998).

The presence of the species was recorded by the first author in May 2013, in Kalakhedi beat (27° 22′ 11.8″ N; 76° 31′ 57.5″ E) of Akbarpur Range in Sariska Tiger Reserve (STR) (25° 5′–27° 33′ N; 74° 17′–76° 34′ E), which is the first record for this species in north-eastern Rajasthan.

Five belt transects of 500 x 6 m were laid at Kalakhedi where lizard distribution was recorded and active burrows were counted by two observers during June 2013. Since, the population is confined to a small patch, more belt transects could not be laid.

In all, 146 active burrows were recorded in the study area. The estimated density of active burrows in the study area was 98 ±42.92 SE/ha (13.86–182.13 burrows /ha, 95% CI). The reported density of active burrows in dry districts of Rajasthan is as follows: 1 burrow/ha in Barmer, 28.85 burrows/ha in Jaisalmer, 51.59 burrows/ha in Thalar substrate or gravel plains (Ramesh and Ishwar 2008) and 324 burrows/ha in Tal Chhapar Wildlife Sanctuary (Das *et al.* 2012). In Abdasa tehsil of Kachchh, Gujarat, the estimated burrow density was 90.83±58.14 SE/ha in 2007, but had declined to 30.95 ±19.99 SE burrows/ha in 2010 (Jhala *et al.* 2012). The recorded population of Spiny-tailed Lizard in STR is isolated and confined to peripheral rocky hillocks interspersed in a matrix of human-dominated landscape subjected to livestock grazing. It is recommended that prevention of livestock grazing and not allowing any watershed management activities in this area is vital for the survival of this species.

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14. PHOTOGRAPHIC RECORD AND FIELD OBSERVATIONS OF A BROWN-SPOTTED PIT VIPER

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On November 05, 2013, during a field survey of vertebrates of Namdapha National Park (27° 29′ 27.8″ N; 96° 22′ 32.2″ E; 516 m above msl), Changlang district, Arunachal Pradesh, India, a team of biologists came across what appeared to be a Brown-spotted Pit Viper approaching a small rodent on the forest floor. They observed the snake for nearly 60 minutes. During this time, the snake initially hid itself beneath foliage and left the prey for a while. It approached the prey, which was already dead presumably due to an initial bite, finally after 7–10 minutes and began swallowing the prey.

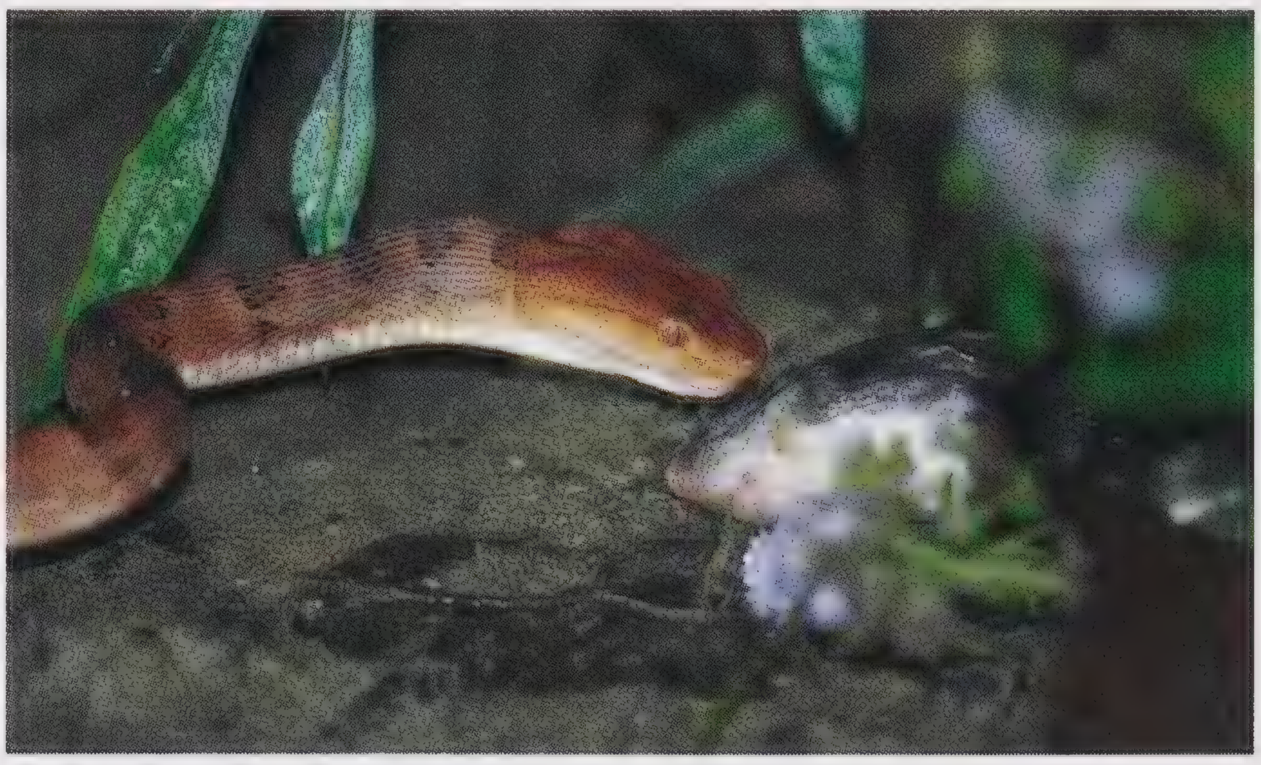

Fig. 1: The viper approaching its prey

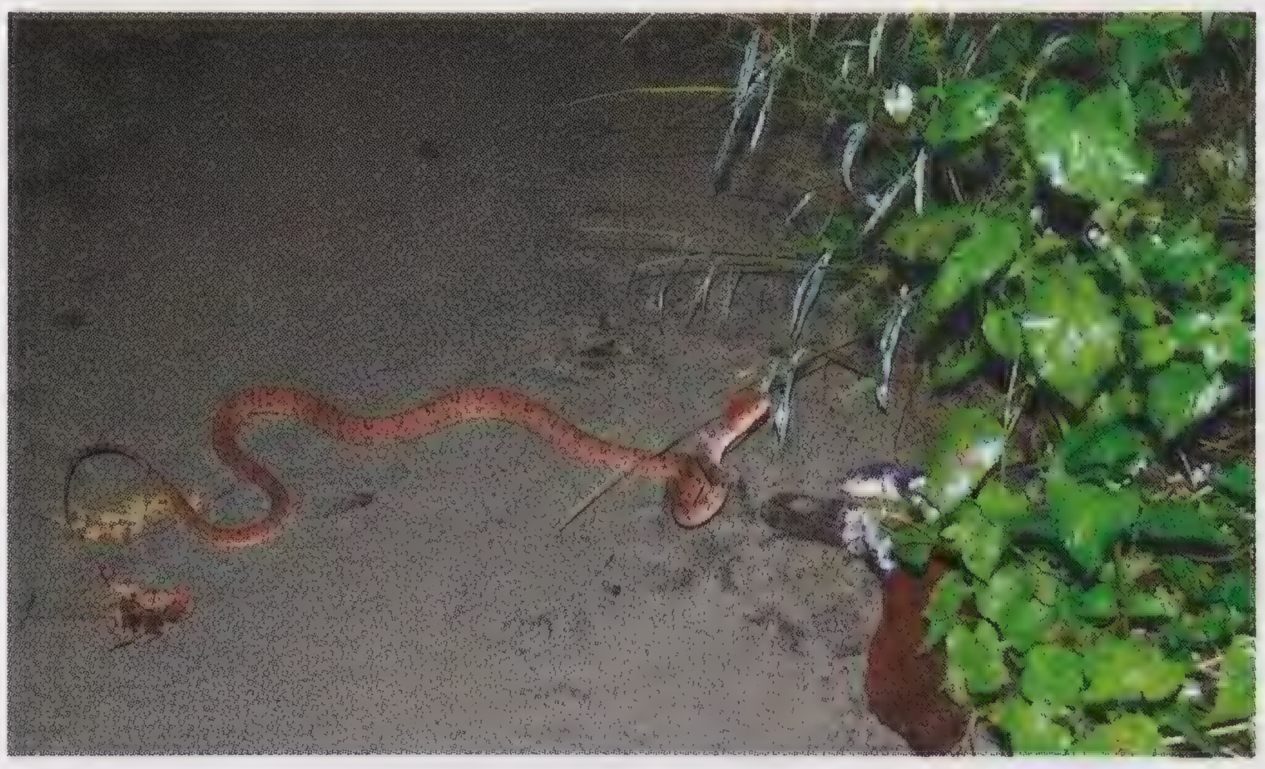

Fig. 2: Full view of the viper

Observations were made and photographic records obtained (Figs 1–3). An imaginary line of the body from head to tail (depending on the position of the snake) was measured using a string, which was later measured using a scale to obtain the average length of the snake (Fitch 1987; Jesus *et al*. 2008).

The taxonomic identification of the pit viper is unconfirmed as no scalation data was recorded. Visually, the species appeared similar to *Protobothrops mucrosquamatus*. The type locality of *P. mucrosquamatus* is Naga Hills, which has similar topography to the present recorded location of this viper (Boulenger 1890, 1896; Günther 1864; Levinton *et al*. 2003).

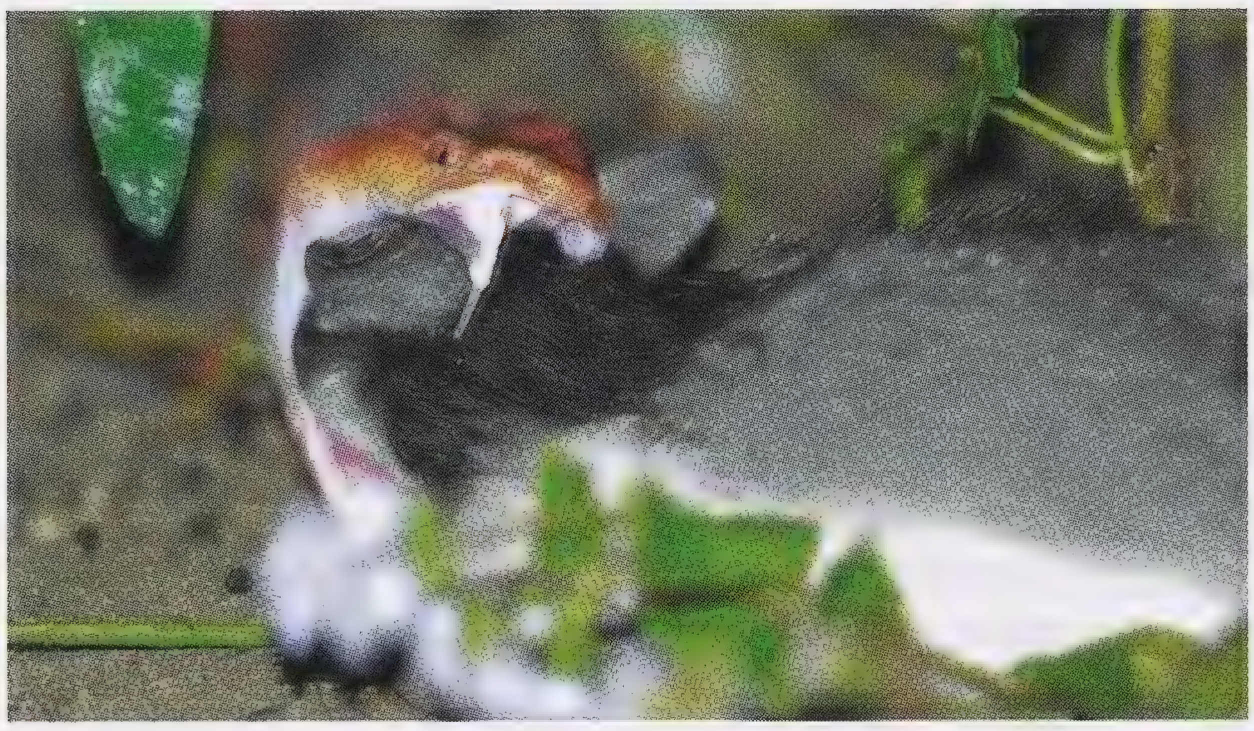

Fig. 3: Feeding on its prey

Description: Slender, elongated yellowish-brown body with series of black-edged large brown blotches along the dorsum. Sixty four separate blotches, and light coloured small lateral blotches along the body. Markings on tail-end are close and form a band-like pattern. Tail tip black. Ventral surface pale. Body scales with pointed tips. Small yellowish-brown scales, devoid of any markings, on dorsal surface of head. Faint lateral stripes extending from eyes to angle of mouth. Prominent rostral scale between the internasals. Eyes with vertical pupil. Fangs approximately 2 cm. Bifid tongue dark with red tinge. Total body length *c.* 120 cm.

Further investigation of this species is needed to ascertain its taxonomic identity.

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15. ON A REPORT OF RED-BELLIED PACU *PIARACTUS BRACHYPOMUS* (CUVIER, 1818), (CHARACIFORMES: CHARACIDAE) FROM MUVATTUPUZHA RIVER, KERALA, INDIA

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Piaractus brachypomus, an introduced fish species from South America of Family Characidae, commonly known as Red-bellied Pacu, was collected from Mukkam in Muvattupuzha river, Kerala. It closely resembles the Red Piranha *Pygocentrus nattereri*, but differs from it in terms of feeding habits, dentition, and behaviour. Pacu species are omnivores, while piranhas are highly carnivorous. The lower jaw in pacu is thin and equal to the upper jaw, whereas in piranha, the lower jaw is thicker and juts out beyond the upper jaw. Pacus have two rows of molar-like teeth, while piranhas have one row of pointed razor sharp teeth (Anon. 2010–2011; Datta and Nandeesha 2006).

Invasive alien fish species are one of the emerging potential threats to indigenous species (Ajithkumar *et al.* 1998; Gopalakrishnan and Ponnaiah 1999; Katwate *et al.* 2012; Kottelat and Whitten 1996; Krishnakumar *et al.* 2009; Menon 1979; Molur and Walker 1998; Raghavan *et al.* 2008; Shetty *et al.* 1989). Like some other exotic species, *Piaractus brachypomus* was introduced to India from Bangladesh between 2003 and 2004 for the aquaculture and aquarium trade (Chatterjee and Mazumdar 2009; Singh and Lakra 2011). It has been reported from the rivers of Tripura (Datta and Nandeesha 2006), Periyar river, Kerala (Dahanukar *et al.* 2011; Singh and Lakra 2011), Dimbhe reservoir, Maharashtra (Singh and Lakra 2011), and Chalakudy river, Kerala (Katwate *et al.* 2012).

This communication highlights the occurrence of *Piaractus brachypomus* in Muvattupuzha river, Kerala, which

Table 1: Biometric characters of *Piaractus brachypomus* (n = 2)

Characters (in mm)	Range (mm)	Mean (mm)	Standard Deviation
Standard Length (mm)	327–347		
% SL			
Head Length	26.23–27.95	27.13	1.17
Body Depth	51.38–55.62	53.50	3.00
Pre Dorsal Length	56.27–56.77	56.52	0.36
Post Dorsal Length	55.66–57.64	56.65	1.40
Pre Pectoral Length	24.46–24.50	24.48	0.02
Pre Ventral Length	50.46–51.00	50.73	0.39
Pre Anal Length	74.62–77.81	76.21	2.26
Dorsal Fin Length	23.05–23.24	23.15	0.13
Dorsal Fin Base	23.24–23.63	23.44	0.28
Pectoral Fin Length	19.27–21.61	20.44	1.66
Anal Fin Length	18.04–18.73	18.39	0.49
Anal Fin Base	25.38–27.67	26.52	1.61
Caudal Length	8.07–8.87	8.47	0.57
% HL			
Snout Length	27.84–30.23	29.03	1.70
Eye Diameter	15.46–23.26	19.36	5.51
Inter Orbital Distance	52.33–53.61	52.97	0.91
Meristic counts			
Dorsal fin rays	18		
Pectoral fin rays	i/15		
Ventral fin rays	i/7		
Anal fin rays	iii/23		
Caudal fin rays	19		
Scales in lateral series	102		

Note: SL = Standard Length; HL = Head Length

could have arrived here due to inter-basin water transfer from the Periyar river through the Idukki Project, or as escapees from aquarium or aquaculture farms. The two specimens were collected using hook and line from Mukkam (9° 47′ 00″ N; 76° 21′ 00″ E) in Kottayam district during an ichthyofaunal survey conducted in March 2012. Biometrics was made to the nearest 0.1 mm using digital calipers (Table 1). The fish was identified based on Jegu (2003). The specimens were deposited in the museum of Zoology Department, Maharaja's College, Ernakulam (F.456 and F.457).

Considering the negative impacts of exotic species on biodiversity, there is an urgent need for standard quarantine procedure on the introduction of exotic species. Other exotic species like *Osphronemus goramy*, *Pangasianodon hypophthalmus*, and *Clarias gariepinus* have been collected from the Muvattupuzha river during our earlier survey (Zeena and Jameela Beevi 2013). The impacts of *P. brachypomus* on natural waters are well-documented (Arsenia 2007; Singh *et al.* 2013; Witkowski and Grabowska 2012), but there is still an urgent need for a detailed investigation of its biology and impacts on indigenous fish fauna in different Indian wetlands.

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16. ICHTHYOFAUNAL DIVERSITY OF TUNDI WETLAND, BAJANA, LITTLE RANN OF KACHCHH, GUJARAT, INDIA

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Kachchh Biosphere Reserve (KBR), Gujarat, India, is known for its unique geomorphology and ecology. KBR (12,524 sq. km) comprises the Great Rann of Kachchh (7,500 sq. km) and the Little Rann of Kachchh (4,954 sq. km) – *rann* is a salt impregnated area, often referred to as saline wasteland. The silts of Little Rann of Kachchh (LRK) show strong affinity to the local soil resources of Gujarat, unlike the silts of Great Rann of Kachchh (GRK), which are the deposits of the Indus river (Meena *et al.* 2005).

The Rann is a seasonally flooded wetland ecosystem, most of which dries up by the end of November/December and remains dry till the arrival of the monsoon in July. The Little Rann of Kachchh (LRK) supports marine, estuarine, and freshwater fish species, as it has a mix of fresh water from the Banas, Brahmni, Rupen, and Machchhu rivers and the salt-brackish water from Surajbari Creek. Singh *et al.* (1999) reported 22 fish species from the Little Rann of Kachchh (LRK), while Baqri and Bohra (2002) recorded 20 species.

In recent times, the fringe areas of the Little Rann at Bajana, Surendernagar district, have been receiving water from the Narmada Canal. This canal ends at Bajana forming the Tundi wetland, which has a spread of up to 2.5 km in diameter (Fig.1). Tundi has water for most parts of the year. This region is an important part of LRK because it is located near the Wild Ass Sanctuary. There is no information on the fish fauna of this area of the Narmada Canal, and hence, we carried out a survey of the Tundi wetland during 2012–2013 to explore its fish diversity. Collections were made by hand and cast net, and were preserved in 10% formalin for further studies. The species were identified following Talwar and Jhingran (1991) and Jayaram (1999).

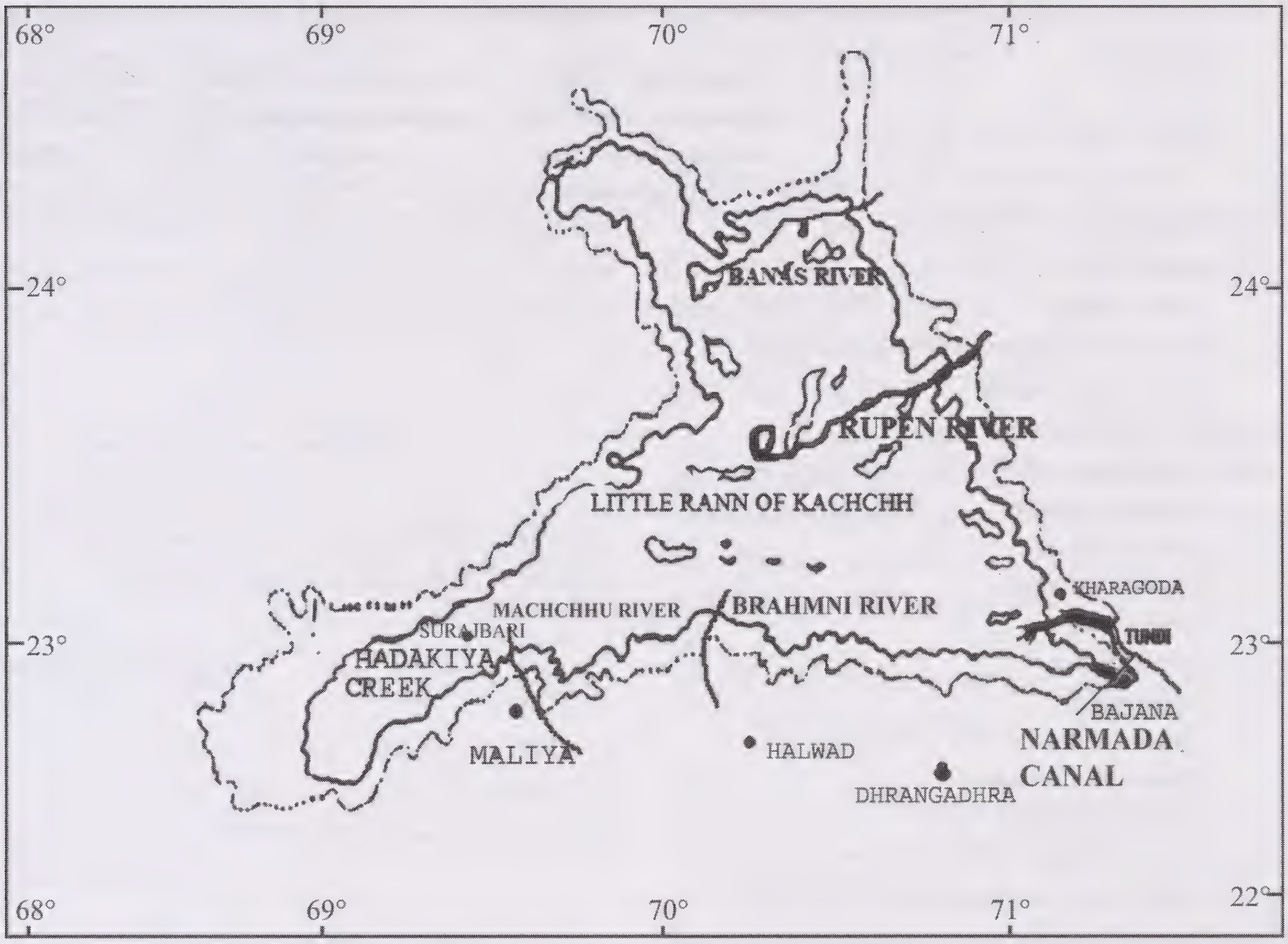

Fig.1: Little Rann of Kachchh, showing Tundi wetland

RESULTS

Twelve species of fish were collected from the Tundi wetland (Table 1). Cypriniformes, represented by eight species belonging to one family, was the dominant order with maximum fish catch and diversity. This was followed by Perciformes, represented by three species belonging to two families, then Beloniformes, represented by one species belonging to one family. The systematic account of the fishes recorded from the wetland is as follows:

Class: Actinopterygii
Order: Cypriniformes
Family: Cyprinidae

Genus: *Salmophasia* Swainson

1. *Salmophasia bacaila* (Hamilton, 1822)

Material examined: 1 ex., Tundi wetland at Bajana, Surendernagar, 29.xii.2012, Coll.: S. Kumar & H.S. Banyal, Reg. No. V/2999.

Diagnostic Characters:

D iii 7; A iii 11; P i 11; V i 8.

Body elongated and strongly compressed; mouth oblique; dorsal fin inserted well in advance of anal fin; scales very small; lateral line slightly decurved, with 105 scales; fins hyaline, silvery in colour.

Genus: *Rasbora* Bleeker

2. *Rasbora daniconius* (Hamilton, 1822)

Material examined: 3 ex., Tundi wetland at Bajana, Surendernagar, 27.xii.2012, Coll.: S. Kumar & H.S. Banyal, Reg. No. V/2997.

Diagnostic Characters:

D ii 7; A ii 5; P i 14; V i 8

Body oblong and compressed; mouth small, a fairly distinct blue black mid-lateral stripe from eye to base of caudal fin, fins hyaline, origin of dorsal fin nearer to caudal fin base, pectoral fins shorter than head, lateral line complete with 32 scales; barbels absent.

Genus: *Osteobrama* Heckel

3. *Osteobrama cotio* (Hamilton, 1822)

Material examined: 1 ex., Tundi wetland at Bajana, Surendernagar, 29.xii.2012, Coll. S. Kumar & H.S. Banyal, Reg. No. V/3000.

Diagnostic Characters:

D iii 8; A iii 36; P i 13; V i 8

Body considerably compressed, abdominal edge trenchant from behind pelvic-fin base to anal fin, but rounded in front of pelvic fins; mouth small; barbels absent. Dorsal spine weak and serrated, lateral line with *c.* 65 scales; colour in life silvery with scattered pigment spots on dorsal side; a dark blotch on nape. Scales somewhat deciduous and irregularly arranged.

Table 1: Fish species recorded by earlier workers in the Little Rann of Kachchh and during this study in Tundi wetland at Bajana

Family	Binomial	Singh *et al*. (1999) (Collections mainly from Hadakiya Creek near Surajbari)	Baqri and Bohra* (2002) (Names of collection sites not given)	Present study (Collection from Tundi wetland, Bajana)
Cyprinidae	*Pethia ticto*	-	-	+
	Labeo bata	+	-	+
	Labeo calbasu	+	-	-
	Cirrhinus mrigala	-	+	+
	Salmophasia bacaila	-	-	+
	Rasbora daniconius	-	-	+
	Osteobrama cotio	-	-	+
	Systomus sarana	-	+	+
	Puntius sophore	-	-	+
	Dawkinsia arulius	-	+	-
	Labeo rohita	+	+	-
	Labeo boggut	-	+	-
	Labeo potail	-	+	-
	Labeo fimbricatus	-	+	-
Belonidae	*Xenentodon cancila*	-	-	+
Channidae	*Channa punctata*	-	+	+
	Channa marulius	-	-	+
Cichlidae	*Oreochromis mossambicus*	-	-	+
Bagridae	*Sperata seenghala*	+	-	-
	Mystus cavasius	-	+	-
Ariidae	*Arius sona*	+	-	-
Synodontidae	*Harpodon nehereus*	+	-	-
	Saurida tumbil	+	-	-
Trichiuridae	*Trichiurus lepturus*	+	-	-
Cynoglossidae	*Cynoglossus macrolepidotus*	+	-	-
Clupeidae	*Tenualosa ilisha*	+	-	-
	Tenualosa toli	+	-	-
Engraulidae	*Coilia dussumieri*	+	-	-
	Coilia reynaldi	+	-	-
Chirocentridae	*Chirocentrus dorab*	+	-	-
Mugilidae	*Mugil cephalus*	+	-	-
	Chelon subviridis	+	-	-
	Liza parsia	+	-	-
Polynemidae	*Leptomelanosoma indicum*	+	-	-
	Filimanus heptadactyla	+	-	-
Gobiidae	*Trypauchen vagina*	+	-	-
	Boleophthalmus dussumieri	+	-	-
	Periophthalmus barbarus	+	-	-

Note: + = recorded; - = not recorded

Genus: *Systomus* McClelland

4. *Systomus sarana* (Hamilton, 1822)

Material examined: 1 ex., Tundi wetland at Bajana, Surendernagar, 29.xii.2012, Coll.: S. Kumar & H.S. Banyal, Reg. No. V/3003.

Diagnostic Characters:

D iv 8; A iii 5; P i 14; V i 8

Mouth moderate; barbels two pairs, rostral ones as long as orbit, maxillary pair much longer. Dorsal fin inserted slightly nearer to tip of snout than to base of caudal fin; lateral line complete with 33 scales; a dull blotch on lateral line before base of caudal fin.

Genus: *Pethia* Pethiyagoda *et al.*

5. *Pethia ticto* (Hamilton, 1822)

Material examined: 2 ex., Tundi wetland at Bajana, Surendernagar, 27.xii.2012, Coll.: S. Kumar & H.S. Banyal, Reg. No. V/2897.

Diagnostic Characters:

D iv 8; A ii 5; P i 12; V i 8

Body elongate, short; mouth terminal; barbels absent, dorsal fin inserted posterior to base of pelvic fin; last unbranched ray osseous, strong and serrated at posterior edge, black spot present on pectoral fin; lateral line complete with 25 scales.

Genus: *Puntius* Hamilton

6. *Puntius sophore* (Hamilton, 1822)

Material examined: 2 ex., Tundi wetland at Bajana, Surendernagar, 27.xii.2012, Coll.: S. Kumar & H.S. Banyal, Reg. No. V/2896 (b).

Diagnostic Characters:

D iv 9; A iii 5; P i 15; V i 8

Body short; mouth terminal, dorsal fin inserted equidistant between tip of snout and base of caudal fin, black spot present on dorsal fin; barbels absent; lateral line complete with 26 scales.

Genus: *Cirrhinus* Cuvier

7. *Cirrhinus mrigala* (Hamilton, 1822)

Material examined: 1 ex., Tundi wetland at Bajana, Surendernagar, 29.xii.2012, Coll.: S. Kumar & H.S. Banyal, Reg. No. V/3002.

Diagnostic Characters:

D iv 13; A iii 5; P i 17; V i 8

Body streamlined; snout blunt, often with pores; barbels a single short pair of rostrals only. Dorsal fin as high as body. Pectoral fins shorter than head. Caudal fin deeply forked. Lateral line with 42 scales. Pectoral, pelvic and anal fins orange-tipped (especially during beeding season); dorsal and caudal fins dusky.

Genus: *Labeo* Cuvier

8. *Labeo bata* (Hamilton, 1822)

Material examined: 1 ex., Tundi wetland at Bajana, Surendernagar, 27.xii.2012, Coll.: S. Kumar & H.S. Banyal, Reg. No. V/2902.

Diagnostic Characters:

D iv 10; A iii 5; P i 17; V i 8

Mouth inferior; lips thin, lower lip slightly fringed; dorsal fin inserted closer to snout-tip than base of caudal fin; pectoral fins as long as head, extending to pelvic fins; lateral line with 38 scales, an irregular black blotch present on anterior (fourth to sixth) scales of lateral line.

Order: Beloniformes
Family: Belonidae

Genus: *Xenentodon* Regan

9. *Xenentodon cancila* (Hamilton, 1822)

Material examined: 2 ex., Tundi wetland at Bajana, Surendernagar, 27.xii.2012, Coll.: S. Kumar & H.S. Banyal, Reg. No.V/2903.

Diagnostic Characters:

D 17; A 16; P 11; V 6

Body elongated and slightly compressed; head pointed, beak-like; dorsal fin inserted usually anterior to vertical through origin of anal fin; scales very small; caudal fin truncate, a series of five blotches on sides of body between pectoral and anal fins.

Order: Perciformes
Family: Channidae

Genus: *Channa* Scopoli

10. *Channa punctata* (Bloch, 1793)

Material examined: 2 ex., Tundi wetland at Bajana, Surendernagar, 27.xii.2012, Coll.: S. Kumar & H.S. Banyal, Reg. No. V/2898 and V/2904.

Diagnostic Characters:

D 32; A 21; P 16; V 6

Body elongate and rounded in cross-section; pectoral fins extend to anal fin; ventral fin almost 75% of pectoral fin length; caudal fin rounded. Scales on summit of head large, predorsal scales 12, scales 40 in lateral series.

11. *Channa marulius* (Hamilton, 1822)

Material examined: 2 ex., Tundi wetland at Bajana, Surendernagar, 27.xii.2012, Coll.: S. Kumar & H.S. Banyal, Reg. No. V/2998.

Diagnostic Characters:

D 52; A 32; P 16; V 6

Dorsal fin long; pectoral fins about half head length; ventral fin about 75% of pectoral fin length, rosette of head-scales lies between orbits, frontal head-scale occupying central portion of rosette; two scales between rosette and basal head-scale; 10 scale-rows between preopercular angle and hind border of orbit; predorsal scales 16; scales 68 in lateral series, five dark oval blotches present along the lateral line.

Family: Cichlidae

Genus: *Oreochromis* Gunther

12. *Oreochromis mossambicus* (Peters, 1852)

Material examined: 2 ex., Tundi wetland at Bajana, Surendernagar, 29.xii.2012, Coll.: S. Kumar & H.S. Banyal, Reg. No. V/3001.

Diagnostic Characters:

D xv 10; A iii 11; P 14; V i 5

Snout long; forehead with relatively large scales, starting with 2 scales between the eyes followed by 9 scales up to the dorsal fin; 14 lower gill-rakers; pharyngeal teeth very fine, a duckbill-like snout due to enlarged jaws, often causing the upper profile to become concave in male specimen.

Discussion

Singh *et al.* (1999) reported 22 fish species from LRK, mainly from collections made in Surajbari Creek area, where estuarine conditions prevail. Hence, most of the fishes reported by them are estuarine or marine species. Baqri and Bohra (2002) stated that 20 species of fish occur in LRK, but listed only 8 species, namely *Cirrhinus mrigala*, *Labeo boggut*, *L. fimbricatus*, *L. potail*, *Dawkinsia arulius*, *Systomus sarana*, *Mystus cavasius*, and *Channa punctata.* Our study recorded the presence of 12 fish species from Tundi wetland, of which 4 were recorded by earlier workers in other areas of Kachchh.

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17. *YUCCA DECIPIENS* TREL., A NEW HOST OF FLORIDA RED SCALE *CHRYSOMPHALUS AONIDUM* L. IN INDIA

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Yucca decipiens Trel. (Fig. 1a) is widely grown as an ornamental plant in landscape design. This plant is native to central Mexico, naturally found at elevations between 1,800 and 2,500 m. In nature, this plant forms branches and grows up to 10 m height. The specimen used for this study is not branched and is 30 cm in height. Leaves are stiff, sharp, and edged with a white border. The plant tolerates a wide range of environmental conditions, but is best grown in bright sunlight in subtropical or mild temperate areas. The inflorescence, flowers, fruits, and seeds of some species of *Yucca* are edible (Couplan 1998).

During a routine visit to the botanical garden of our institute, *Yucca decipiens* was found to be attacked by Florida Red Scale from August 2012 to 2014 (Fig. 1b). Scale insects are sap sucking hemipterous insects that include all members of the superfamily Coccoidea. These are closely related to aphids (Aphidoidea), whiteflies (Aleyrodoidea), and jumping plant lice (Psylloidea), which make up the suborder Sternorrhyncha (Gullan and Martin 2003). Scale insects are some of the most serious pests of ornamental plants.

These insects are usually less than 5 mm in length. Florida Red Scale has circular armour made up of three concentric rings. The colour is dark reddish brown with a conspicuous light brown centre (Fig.1c). The adult female is *c.* 2.0 to 2.2 mm in diameter and produces bright yellow eggs, which are deposited under the scale armour in groups of *c.* 10 eggs. The crawlers are bright lemon-yellow, oval (Fig. 1d), and very active; they move quite a distance before settling down. During summer, the life cycle of this pest is completed in less than six weeks, while in winter it undergoes longer life cycle. Heavy infestation was observed from August to September, which decreased up to January. Summer months showed poor infestation. Generally there are six generations in a year, but in the present study the largest scale population increase occurred in monsoon. Heavy and continuous rains during 2013 did not affect the population under observation.

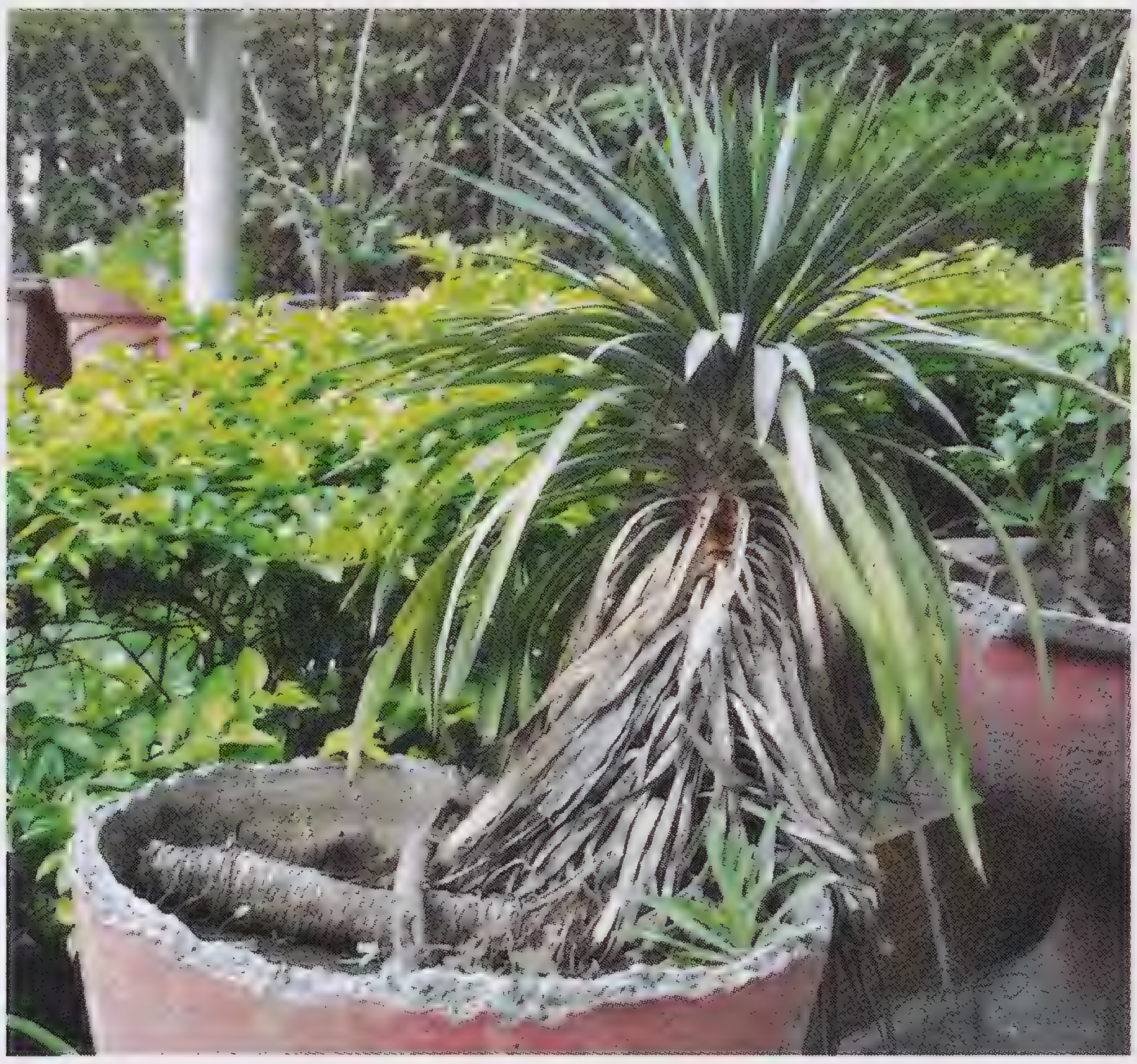

Fig. 1a: Host plant

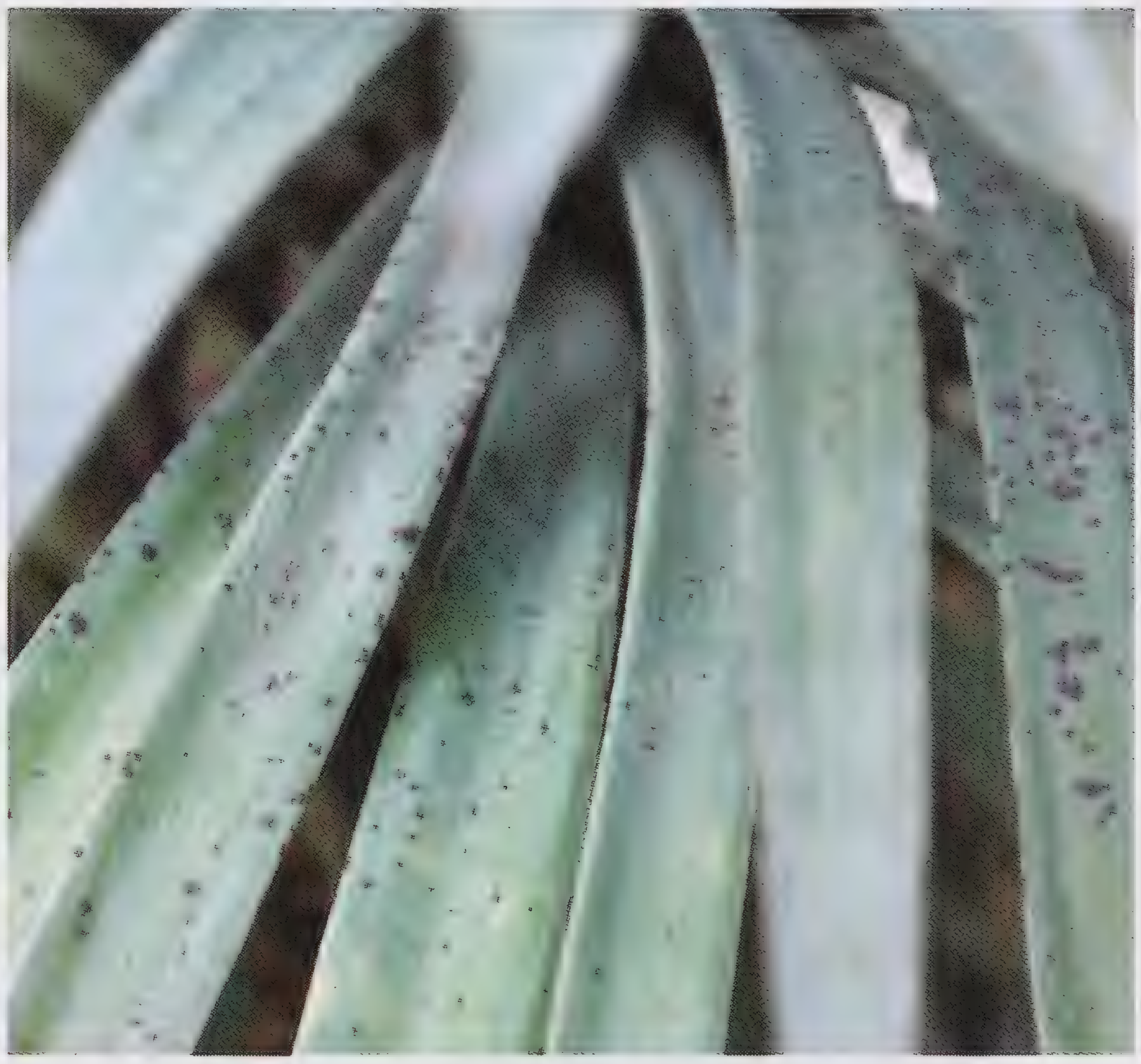

Fig. 1b: Enlarged photograph of infected leaf

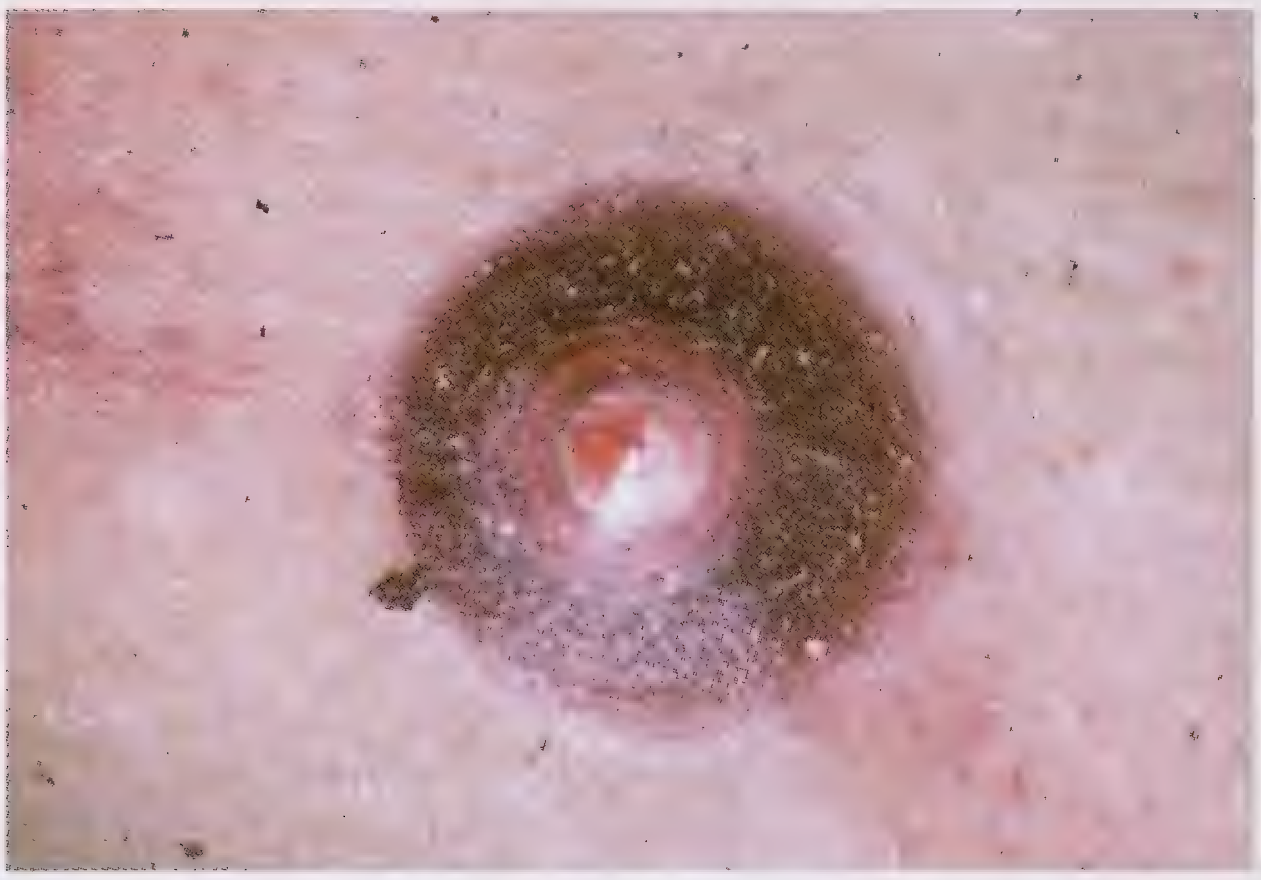

Fig. 1c: Seldome of insect

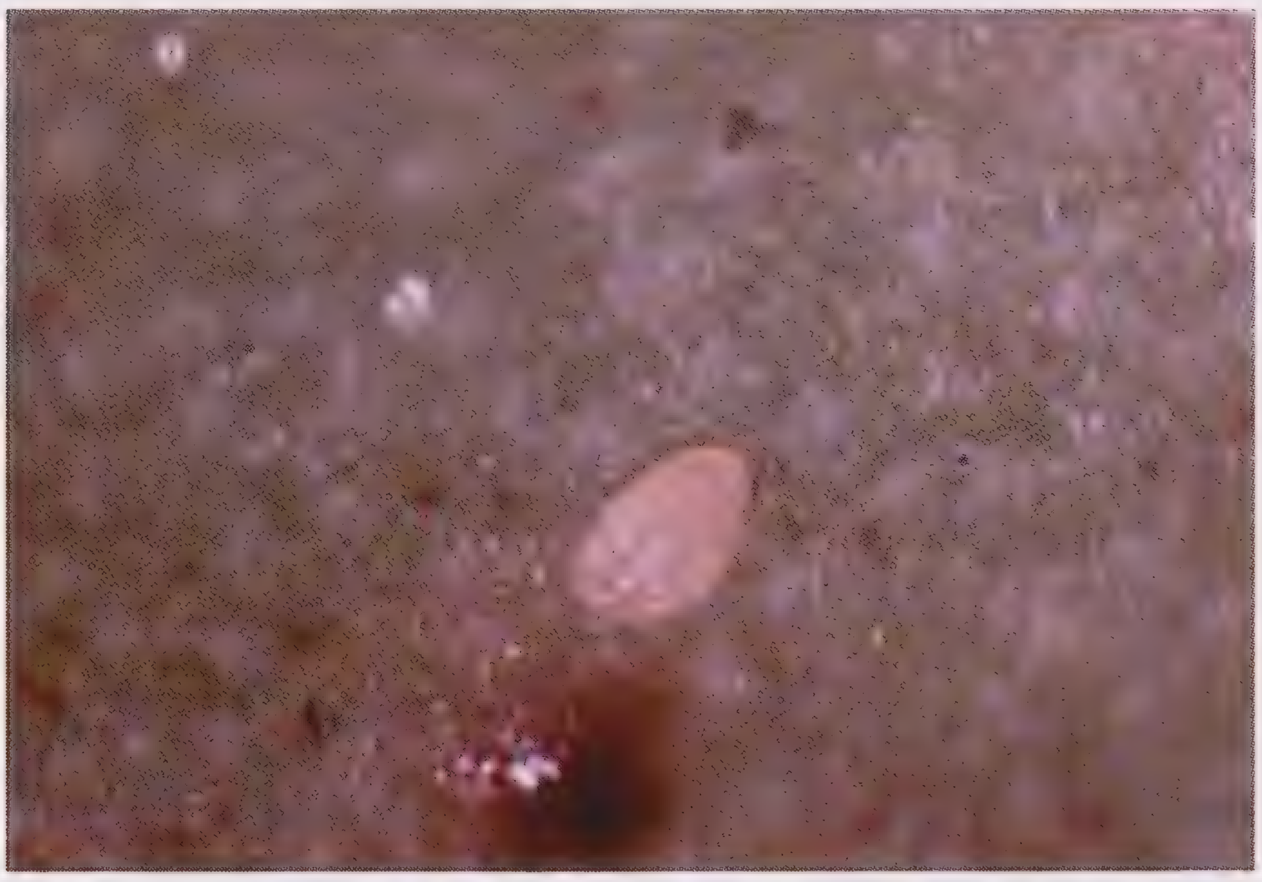

Fig. 1d: Crawler

Usually scales feed on the underside of leaves, but here they are observed on both the surfaces (Hill 1983, 2008; Miller and Davidson 2005; Soto *et al*. 2008). The opposite side of the leaf carries a yellow spot where the scale is feeding. The spots become progressively larger as the scales continue to feed. If the scales are not controlled, the leaves dry up and drop prematurely. Generally scales infest tender shoots, branches, and main stem (Hill 1983, 2008; Miller and Davidson 2005; Schweig and Grunberg 1936; Watson 2005), but in this study they have been reported on leaves only. Scale infestation on plants and its nature of damage reduces the ornamental value of garden plants. Interestingly, no other garden plant nearby was infested by the scale insect. This indicates that *Yucca decipiens* is a new host of Florida Red Scale.

Scales are preyed upon by numerous beneficial insects that keep them under control (Steinberg *et al*. 1986). But no such biocontrol agent was observed during the study period.

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18. MASS OCCURENCE OF STINK BUG *CYCLOPELTA SICCIFOLIA* (WESTWOOD) (HETEROPTERA: PENTATOMOIDEA: DINIDORIDAE) ON *MILLETTIA PINNATA* (L.) PANIGRAHI, AT KANNUR, KERALA, SOUTHERN INDIA

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Cyclopelta siccifolia (Westwood) is a dirty brown, oval-shaped pentatomid bug, with a pungent odour, belonging to Family Dinidoridae. It was recorded as a pest of Coral tree *Erythrina* (L.) (Distant 1902) and several other species of Leguminosae. Beeson (1993) reported *C. siccifolia* congregrating on twigs in crowded colonies. Beeson (1993) reported the host plants of *Cyclopelta* as Coral tree *Erythrina* (L.), Red Gram *Cajanus cajan* (L.) Millsp. and Indian Beech tree *Pongamia* Vent., while McCann (1942) recorded *Cyclopelta siccifolia* on *Pongamia glabra* Vent., at Khandala, Western Ghats. Further, David and Venugopal (1961) recorded it on Tree Wisteria *Sesbania speciosa* Taub. ex Engl., from Coimbatore; Varshney (1967) observed *Cyclopelta siccifolia* (Westwood) on Bastard Teak *Butea monosperma* (Lam.) Taub., while Ranjith *et al.* (1992) recorded it on *Erythrina indica* (Lam.) at Kannur; Hill (1993) on Betel vine *Piper betle* (L.); Nair (1995) on *Moringa* (Adans.) in Maharashtra; Naveed *et al.* (2000) on *Pongamia glabra* Vent. in Karnataka; Joshi *et al.* (2011) on *Millettia pinnata* (L.) Panigrahi (=*Pongamia glabra* = *Pongamia pinnata*) (Fabaceae) in Maharashtra; and Kulkarni *et al.* (2012) on *Holigarna grahamii* (Wt.) Kurz, also in Maharashtra. The present note reports a heavy infestation of *C. siccifolia* on *Millettia pinnata* in Tagore Vidyaniketan Government Vocational Higher Secondary School Campus, Taliparamba, Kannur, Kerala.

During the first week of October 2013, I came across a heavy infestation of *C. siccifolia* on a 6 m tall *M. pinnata* in Tagore Vidyaniketan Government Vocational Higher Secondary School Campus. There were roughly 1,000 bugs within 1 m from the base of the tree. Numerous bugs were also found on the base of the tree, the trunk, and upper branches. A pungent smell was emitted by the bugs and a very fine white thread-like structure was found connecting the bugs in the groups. The majority of them were adults, with a few nymphs. Around 2,000–3,000 bugs were on the tree. The bugs were not flying when disturbed; instead they were found crawling. Upon dislodging and falling to the ground, they crawled back onto the plant. I could not see the infestation on another tree. Though I could not observe these bugs sucking the sap of *M. pinnata*, wrinkling and drying of young leaves and tender branches was observed. Application of neem extract (*Azadirachta indica*) reduced the infestation.

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19. *SOLANUM SISYMBRIIFOLIUM* LAM. – AN ADDITION TO THE FLORA OF JHARKHAND, INDIA

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Introduction

During a floristic survey to Ranchi, Jharkhand, an interesting plant was collected, identified, and deposited in the herbarium of Post Graduate Department of Botany, Utkal University, Bhubaneswar. After consultation of available literature, the plant was found to be a new record for the state of Jharkhand (earlier part of state of Bihar). Haines (1921–25) and Mooney (1950), earlier workers in the state of Bihar and Orissa (now Odisha), did not report this species. Recent workers, *viz.* Paria and Chattopadhyay (2000) and Singh (2001) too have not reported this species from Jharkhand. The updated taxonomy, diagnostic characters, phenology, ecology and distribution are provided in brief.

Solanum sisymbriifolium Lam. Illus. 2: 25. 1792; Matthew, Exot. Fl. Kodaikanal 162. 1969; Naik, Fl. Osmanabad 226. 1979; Gamble, Fl. Madras II: 938. 1986 (Rev. ed.); Singh *et al.*, Fl. Maharashtra state (Dicotyledons) II: 505. 2001. *Solanum balbisii* Dunal – Sims, Bot. Mag. 52: t. 2568. 1825; Dassanayake & Fosberg, Rev. Handb. Fl. Ceylon VI: 387. 1987 (Solanaceae).

Annual erect herb, height up to 1 m; stem and branches viscid, hairy, and armed with straight, sharp, flat, orange-yellow prickles up to 15 mm in length, thinly covered with grey tomentum. Leaves 10–15 x 4–6 cm, pinnately lobed into 4–6 coarse lobes, oblong-lanceolate, pubescent on both sides with stellate glandular hairs. Inflorescence inter-nodal, arising from the foliage, unbranched racemes composed of 1–10 perfect or staminate flowers. Flowers white, often 1–1.5 cm diameter, in lateral racemes. Berries globose, yellow, smooth. Seeds large, pitted.

Flowering & Fruiting: June–September.

Ecology: Commonly found in wastelands.

Distribution: South America, North America, Europe, Asia, Africa, and Australia. India: Western Ghats, Nilgiris, Pulney hills, Coimbatore.

Specimen Examined: Ranchi, Jharkhand; F.N. 26001

Note: A viscid, hairy herb of South American origin, it is now widely distributed throughout the world. It has naturalized in North America, Europe, Asia, Africa, and Australia. In many cases it acts as an invasive. The plant is used as a trap crop for potato cyst nematodes; the fruit is a source of solasodine (used to synthesize hormones) and consumed by birds and humans.

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20. *FICUS VARIEGATA* BLUME (MORACEAE) – A NEW RECORD FROM ARUNACHAL PRADESH, INDIA

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Introduction

The genus *Ficus* is represented by *c*. 750 species distributed worldwide, mainly in tropical and subtropical forest (Berg 2011). A total of 115 species have been listed from India (Chaudhary *et al*. 2012), of which 51 taxa have been reported from Arunachal Pradesh (Giri *et al.* 2008). During field survey in the eastern part of Arunachal Pradesh, a few specimens of *Ficus* were collected from three districts, namely Papumpare, West Siang, and Lohit. After survey of literature, examining type and other specimens in CAL, ARUN, ASSAM herbaria, and discussion with Dr. Venkata Jana, we confirmed the identity as *Ficus variegata* Blume. This species is a new distributional record to the state of Arunachal Pradesh. Earlier, *F. variegata* was reported from Andaman & Nicobar Islands, Assam, Bihar, Meghalaya, and Sikkim in India. It is also known to occur in Australia, Bangladesh, China, Japan, Malaysia, Myanmar, Solomon Islands, and Thailand.

The specimens were deposited in the herbarium of Forestry Department, NERIST and Botanical Survey of India, Itanagar (ARUN).

Ficus variegata Blume, Bijdr. Fl. Ned. Ind. 9: 459. 1825; King, Ann. Roy. Bot. Gard. (Calcutta) 1: 169, t. 212, 213. 1888 & in Hook. f., Fl. Brit. India 5: 535. 1888; Prain, Bengal Pl. 2: 737. 1903; Brandis, Indian Trees 609. 1906; Corner, J. Mal. Br. R. As. Soc. 11: 48, f. 25, 26. 1933 & Gard. Bull. Singapore 21(1): 83. 1965; Berg & Corner in Nooteboom, Fl. Malesiana 17(2): 347. 2005; Berg *et al*., in Santisuk *et al*., Fl. of Thailand 10(4): 576. 2011; Chaudhary *et al*., Taiwania 57(2): 204. 2012.

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F. racemifera Roxb., Fl. lnd. 3: 560. 1832; Wight, Icon. Pl. Ind. Orient. 2: t. 639. 1843.

Covellia racemifera (Roxb.) Miq., Hook. London J. Bot. 7: 465. 1848.

Vernacular name: Ramn (Wan.); Saep-lee (D. Mish.); Aapombo (I. Mish.).

Type locality: Indonesia.

Trees, up to 30 m tall, deciduous; bark whitish with longitudinal ridges, trunk buttressed, straight; branches numerous on top, spreading in all directions; aerial roots absent. Leaves spirally arranged; lamina simple, broadly ovate to ovate-elliptic, sometimes cordate, 10–28 × 7–12.5 cm, symmetrical, apex with *c.* 1 cm long acumen, base rounded or cordate to subcordate, margins entire, subrepand or coarsely denticulate; adaxial surface glabrous, abaxial surface minutely appressed, puberulous on the main veins; lateral vein 4–5 pairs, basal pair 2, distinct, ½ to ¼ the length of the lamina, often unequal in length; tertiary venation reticulate; waxy glands in slit-shaped extension of the axils of the main lateral veins; petiole 2–7 cm long, glabrous or appressed-puberulous; stipules 0.8–1 cm, glabrous, ovate-lanceolate, caducous. Figs in fascicles from woody tubercles, ramiflorous to cauliflorous, dioecious, drooping, pedunculate; peduncle 1–3 cm long; basal bracts 3, 0.5–0.8 cm long, verticillate and persistent; receptacle globose or subglobose to pyriform, *c.* 5 cm long, 3–5 cm in diam., smooth, glabrous, yellowish-green, pink to red with white streaks and spots when ripe, sometimes with a short stipe (up to 8 mm); ostiole slightly depressed, 4–5 mm across, 1.5–2 mm depth; Staminate flowers: sessile, found near ostiole, 2–2.5 mm long; perianth more or less polyphyllous; tepals 3 or 4, linear-lanceolate or spatulate, 1.5–2 mm long; stamens 2, anthers broadly ovoid, filaments short; Pistillate flowers: long-style flowers sessile or shortly pedicellate, 2.5–3 mm long; tepal 3 or 4, gamophyllous or basally connate, style lateral, cylindric, stigma infundibuliform; short-style flowers with the pedicel 2–3 mm long; tepals gamophyllous, tubular, 4 or 5 lobed, 1–1.5 mm long, inflated at apex; ovary ovoid, red-brown to pale; style lateral, white; stigma infundibuliform. Achenes ovoid or obovoid.

Flowering: January–March;

Fruiting: June–July.

Habitat: Distributed in tropical evergreen forest in small numbers. During field survey, it was recorded only from three districts of the state.

Distribution: INDIA: Andaman & Nicobar Islands, Assam, Bihar, Meghalaya; Australia; Bangladesh; China; Japan; Malaysia; Myanmar; Solomon Islands; Thailand.

Specimen Examined: Arunachal Pradesh: Lohit, Tezu, on the way to Dwaraka Nagar, 22.vi.2011, R. Buragohain 232; Papumpare, Karsingsa, 200 m, 16.vii.2011, R. Buragohain 293; West Siang, on the way from Likabali to Gensii 290 m, ??.xii.2010, R. Buragohain 557; West Siang, Likabali, 380 m, 25.ix.2012, R. Buragohain 916 (NERIST).

Additional specimen examined: Meghalaya, Khasia hills, Feb. 1886, G. Mann 36 (CAL); Andaman, 20.iii.1916, C.E. Parkinson 1113 (CAL); Sikkim, 21.iii.1887, Dr. King (?) (CAL); Tebba Valley, 21.iii.1887, G.A. Gammie (?) (CAL); Assam, Dhonsiri river, June 1886, G. Mann (?) (CAL).

Note: The species can be distinguished by its buttressed trunk and branches on the top. Leaves spirally arranged, ovate or sub-ovate. Figs in fascicles from woody tubercles in older trunk, smooth, 3–5 cm in diameter.

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21. SMILACACEAE IN DARJEELING AND SIKKIM HIMALAYA, INDIA

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Introduction

The Darjeeling and Sikkim parts of Eastern Himalaya are contiguous and situated between 26° 31′–28° 7′ N and 87° 59′–89° E. These hills cover about 9,020 sq. km out of the total 1,22,802 sq. km area of Eastern Himalaya (Negi 1990). Great altitudinal as well as climatic variations favour luxuriant growth of vegetation in these mountainous regions. The floristic diversity in these regions is well-known for its innumerable rare, endangered, endemic, and medicinally useful plants (Hara 1966, 1971; Hara *et al.* 1978; Hooker 1849, 1892; Matthew 1981; Ohashi 1975; Panda 2009; Samanta 2006).

The members of the family Smilacaceae are distributed over tropical to temperate zones. The present note records the species of Smilacaceae collected from Darjeeling and Sikkim Himalaya, India.

Material and Methods

Field and herbarium methods were followed according to Jain and Rao (1977). The specimens were identified with the help of literature and confirmed in Central National Herbarium (CAL), Howrah, West Bengal. The voucher specimens were deposited in CAL.

Enumeration

Eight species in two genera of the monocotyledonous family Smilacaceae have been recorded from Darjeeling and Sikkim Himalaya. The genera and species are arranged alphabetically. Each species is provided with a protologue and relevant references, vernacular name(s) when available, description, flowering and fruiting time, local and general distribution, *exsiccatae* i.e. voucher specimens citing locality, habitat and altitude where collected, and use(s) when available.

KEY TO THE GENERA

1. Male peduncle 2.5–6 cm long, tepals united ...... *Heterosmilax*
— Male peduncle up to 1.5 cm long, tepals free .... *Smilax*

Abbreviations Used

BP = Bengal Plants (Prain, D.); EFPN = An Enumeration of the Flowering Plants of Nepal (Eds: Hara, H. *et al.*); FB = Flora of Bhutan (Eds: Grierson, A.J.C. & D.G. Long); FBI = The Flora of British India (Ed.: Hooker, J.D.); FEH = The Flora of Eastern Himalaya (Ed.: Hara, H. / Ohashi, H.); FPK = The Flowering Plants of Kurseong (Matthew, K.M.).

Heterosmilax japonica Kunth., Enum. Pl. 5: 270.1850. *H. indica* A. DC., Monog. Phan. 1: 43. 1878; FBI 6: 314. 1892; FB 3(1): 36. 1994.

Shrubby tendril climber. Stem terete, greenish-yellow, internodes 9–12 cm long, glabrous. Stipules modified into tendrils. Petioles 1.2–2.3 cm long, terete, glabrous; lamina 12–16 x 8.5–12.5 cm, oblong-lanceolate, margin entire, apex acuminate to caudate, cuspidate, base cuneate to cordate, membranous, both surfaces shiny, glabrous, 5-nerved, parallel, convergent, middle 3 more prominent than others, yellowish-green. Umbel compound, axillary; peduncle 2.5–6 cm long, slender, flattened, smooth. Bracts minute, ovate, acuminate; pedicels 5–6 mm long, flat, glabrous. Male umbels obovoid, deep brown, flowers 3.5–4.5 x 1.7–2 mm; tepals united; stamens 3, anthers 2 x 1 mm, white, base attenuate, apical lobes 3, oblong, filaments 4–6 mm long, connate (female flowers not seen). Berries 0.8–10 mm in diam., globose, blackish; seeds 5.5–5.7 mm in diam., hemispheric, pale orange-brown.

Fl. & Fr.: April to June.

Local distribution: Darjeeling – less common; found at Jalapahar-Rung-Dung areas, 1,500–2,650 m.

General distribution: INDIA: tropical and subtropical Himalaya, Assam, and Meghalaya.

Exsiccatus: Darjeeling: Jalapahar, in a moist rocky place, 2,150 m, 12.xi.2013, *Samanta* 48.

KEY TO THE SPECIES OF SMILAX L.

1. Inflorescence panicled spike, drooping..................... *S. aspera*
— Inflorescence elongated umbellate raceme or whorled or umbel 2
2. Inflorescence elongated umbellate raceme or whorled............ .... *S. perfoliata*
— Inflorescence umbel 3
3. Lamina 15–18 x 10.2–12.6 cm; costae 7 ....*S. ovalifolia*
— Lamina 1.9–13.5 x 1.2–8.5 cm; costae 3–5 4
4. Petioles more than 1.2 cm long...5
— Petioles up to 1.2 cm long...6
5. Male umbels 30–40 flowered; pedicels almost absent .... *S. aspericaulis*
— Male umbels up to 25 flowered; pedicels 6–8 mm long.......... ....*S. lanceifolia*
6. Tendrils twisting to right; stem strongly prickled.........*S. ferox*
— Tendrils twisting to left; stem glabrous, without prickles........ .... *S. glaucophylla*

Smilax aspera L., Sp. Pl. 1028. 1753; FBI 6: 306. 1892; FEH 414. 1966; EFPN 1:78. 1978. *S. maculata* Roxb. *ex* D. Don, Prodr. Fl. Nepal 49. 1825.

Shrubby tendril climber. Tendrils simple, terete, stipular. Stem and branches with prickles. Lamina ovate, deltoid to lanceolate, margin entire, apex acute to acuminate, base hastate or cordate, blotched with white. Inflorescence panicled spike, drooping. Flowers dioecious, fragrant; tepals 6, subequal, free, white; anthers oblong, 2-celled; carpels 3, ovary 3-celled, stigmas 3, recurved. Berries globose, blue – black, 3-seeded.

Fl. & Fr.: September to July.

Local distribution: Darjeeling – common; Kurseong, Neora Valley National Park, 1,500–3,200 m; Sikkim – common; Yaksum, Rishi, Tingling, up to 2,600 m.

General distribution: INDIA: Eastern Himalaya, Darjeeling, Sikkim, Arunachal Pradesh, Meghalaya, Assam. Mediterranean and east Africa to India, Nepal, Myanmar, and Sri Lanka.

Exsiccatae: Darjeeling: Chitray, Neora Valley National Park, in a moist rocky area, 2,500 m, 12.xi.2013, *Samanta* 25; Sikkim: Soreng, in rock crevices, 1,560 m, 15.xi.2013, *Samanta* 211.

Uses: The roots of this plant are prescribed in urinary and skin diseases.

Smilax aspericaulis Wall. *ex* DC., Monog. Phan. 1: 195. 1878; FBI 6: 306. 1892; FB 3 (1): 29. 1994.

Vernacular names: Dathun, Kukurdaini (Nepali).

Shrubby tendril climber. Tendrils simple, terete, glabrous, stipular. Branches terete, scabrid, with 5–6 mm long bristles, often with recurved prickles. Petioles 1.2–2.5 cm long, sheathing below the mid-internodes; lamina 10–13.5 x 4–8.5 cm, ovate to oblong or linear-oblong, margin entire, apex acute, base rounded to cuneate, costae 3 from base. Umbels solitary or 2–3 on peduncles, peduncles 9–15 mm long, bracteate. Male umbels 30–40 flowered; pedicels almost absent; tepals 6, free, creamy white, reflexed in older flowers; stamens as long as tepals (female flowers not seen). Berries 8–10 mm across, globose.

Fl. & Fr.: September to April.

Local distribution: Darjeeling – common; Mangpoo, Birch Hill, 300–2,100 m; Sikkim – common; Singling Basty, Yaksum, up to 2,200 m.

General distribution: INDIA: Eastern Himalaya, Darjeeling, Sikkim, Khasia Hills, Andaman Islands; Myanmar.

Exsiccatae: Darjeeling: St. Mary's, Kurseong, in a moist rocky place, 1,548 m, 4.v.1994, *Samanta* 169; Sikkim: Soreng, in rock crevices, 1,560 m, 30.x.1995, *Samanta* 898.

Use: The ripe fruits are edible.

Smilax ferox Wall. [Cat. No. 5119. 1830, *nom. nud.*] *ex* Kunth, En. Pl. 5: 251. 1850; Monog. Phan. 1: 130. 1878; FBI 6: 307. 1892; FEH 415. 1966; EFPN 1: 89. 1978; FPK 116. 1981; FB 3(1): 33. 1994.

Shrubby tendril climber. Tendrils simple, coil dextrorsely, i.e. twisting to right, glabrous, stipular. Stem solid, much branched, armed with strong prickles, glabrous. Petioles 3–4 mm long, coriaceous, sheathing half of its length; lamina 1.9–8 x 1.5–2.8 cm, elliptic-ovate-oblong, margin entire, apex acute, base cuneate or rounded, yellowish green, membranous, glabrous, costae 3–5 from base, convergent. Umbels solitary or 18–20 flowered in fascicles, dioecious. Peduncles 1.2–1.4 cm long; bracteoles conspicuous, ovate, acuminate; pedicels 2–3 mm long. Male umbels globose, 1.2–1.3 cm diam.; tepals 6, free, 3 x 2 mm, lanceolate, light brown; filaments 1.4–2.1 mm long, anthers 0.5–10 x 0.3–0.4 mm, oblong. Female umbels conical, 1 mm diam., green; ovary swollen at base, stigma papillose. Berries 8–10 mm across, green-purple, 1–2 seeded. Seeds 5.5–5.7 mm diam., reddish-brown.

Fl. & Fr.: April to December.

Local distribution: Darjeeling – abundant; Manebhanjan, Tonglu, 1,850–3,200 m; Sikkim – abundant; Gangtok, Rengli, 1,500–2,700 m.

General distribution: INDIA: Eastern Himalaya, Darjeeling, Sikkim, Arunachal Pradesh, Assam, Manipur; Nepal.

Exsiccatae: Darjeeling: Meghyma, in a rocky area, 3,000 m, 16.iv.1994, *Samanta* 114; Sikkim: Rengli, in rock crevices, 1,600 m, 16.xi.2013, *Samanta* 371.

Smilax glaucophylla Koltz. in Reise Prinz. Wald. Bot. 45, t, 91. 1862; FEH 415. 1966; EFPN 1: 89. 1978; FB 3(1): 35. 1994. *S. elegans* Wall. (Cat. No. 5117 B. 1830, *nom. nud.*) *ex* A. DC., Monog. Phan. 107. 1878. *S. parviflora* Wall. *ex* Hook. f., FBI 6: 304. 1892. *S. longibracteolata* Hook. f., FBI 6: 305. 1892.

Vernacular names: Harina-shuk-china (Bengali); Kukardara (Nepali).

Shrubby tendril climber. Stem terete, glabrous, without prickles, shiny, internodes 9.5–22 cm long. Tendrils simple, coil sinistrorsely, i.e. twisting to left, terete, solid, glabrous, stipular. Petioles up to 1.2 cm long, with a sheath; lamina 2.5–11 x 1.2–7 cm, ovate-cordate, margin entire, apex acute, base cordate, membranous, costae 3–5 from base. Umbels many-flowered, bracteoles minute; peduncle 1.3–1.5 cm long; pedicels 1–2 mm long, glabrous; tepals 6, linear-oblong, free, 2 x 1 mm, ovate-oblong, apex acute, glabrous; stamens 4, didynamous, filaments connate, anthers 1 mm long, white, staminodes 1–3; ovary ovoid. Berries globose.

Fl. & Fr.: April to September.

Local distribution: Darjeeling – less common; Neora Valley National Park, Tonglu, up to 3,050 m.

General distribution: INDIA: Eastern Himalaya; Tibet, West China.

Exsiccatus: Darjeeling: way to Jorepukri, growing along roadside among rocks, 2,550 m, Neora Valley National Park, 23.iv.1995, *Samanta* 305.

Smilax lanceifolia Roxb., Fl. Ind. ed. 2, 3: 792. 1832; Monog. Phan. 1: 57. 1878; FBI 6: 308. 1892; FEH 415. 1966; FPK 116. 1981; FB 3(1): 32. 1994.

Shrubby tendril climber. Branches slender, terete, glabrous. Tendrils simple, stipular, sheathing up to middle of petiole. Petioles 2–2.7 cm long; lamina 11–13 x 4.9–8 cm, oblong-lanceolate, margin entire, apex acuminate, base rounded, membranous, coriaceous, costae 5 from base, prominent. Male umbels up to 25 flowered, subsessile, peduncles up to 1.5 cm long; bracteoles ovate, acute; pedicels 6–8 mm long; tepals 6, linear, subequal, free; filaments filiform, anthers 1.1 x 0.5 mm, oblong; female umbels subsimilar, peduncle up to 1.2 cm long, stout, flattened; bracteoles subulate; staminodes 3, ovary trigonous, stigmas recurved. Berries 6–6.5 mm across.

Fl. & Fr.: May to December.

Local distribution: Darjeeling – less common; Kurseong, Neora Valley National Park, 1,500–3,200 m; Sikkim – less common; Yaksum, Rishi, up to 2,200 m.

General distribution: INDIA: subtropical to temperate Himalaya, Assam, Khasia Hills, Manipur; Nepal; Myanmar; Thailand; Indo-China.

Exsiccatae: Darjeeling: St. Mary's, Kurseong, in a rocky area, 1,548 m, 4.v.1994, *Samanta* 159; Sikkim: Pangthang, among rocks, 1,900 m, 20.xi.1995, *Samanta* 1016.

Smilax ovalifolia Roxb., Fl. Ind. ed. 2, 3: 794. 1832; FEH 417. 1966; FB 3(1): 30. 1994. *S. macrophylla* Roxb., Fl. Ind. 3: 793. 1832; FBI 6: 310. 1892, *non* Willd. 1805.

S. zeylanica L., Sp. Pl. 1029. 1793; FBI 6: 309. 1892; FEH 3: 135. 1975; EFPN 1: 79. 1978.

Vernacular names: Kumarika Mitri, Rajdan-tini, Muter (Bengali); Kukurdaini (Nepali).

Shrubby tendril climber. Stem terete, stout, hollow, glabrous, with light striations, often sparsely prickled, internodes 8–9 cm long. Tendrils simple, coiled dextro sinistrorsely, flat, glabrous, stipular. Petioles 2.1–2.5 cm long; lamina 15–18 x 10.2–12.6 cm, broadly ovate, margin entire, apex acute, base cuneate, glabrous, greyish, costae 7. Umbel paniculate; peduncles up to 1.5 cm long, branched, many flowered; bracteoles 1.2–1.4 mm; pedicels 8–13 mm long; tepals 6, free; filaments 5.2–5.4 mm long, anthers 1.2–1.5 x 0.4–0.6 mm, linear. Berries 0.6–0.8 mm in diam., red, 1–2 seeded.

Fl. & Fr.: April to November.

Local distribution: Darjeeling – common; Gorubathan, Pesok, 110–800 m; Sikkim – common; Jorethang-Nayabazar, Melli, Ravongla, up to 1,000 m.

General distribution: INDIA: Foothills to subtropical Himalaya, central and southern provinces; Bangladesh; Myanmar; Indo-China.

Exsiccatae: Darjeeling: Bamanpokri, in a moist loamy soil, 200 m, 14.i.1995, *Samanta* 486; Sikkim: Ravongla, growing along roadside among rocks, 900 m, 17.xi.2013, *Samanta* 375.

Uses: The seeds are used in the treatment of dysentery, abnormal discharge of semen, infection in kidney and urine, venereal diseases, and rheumatism.

Smilax perfoliata Lour., Fl. Cochin. 622. 1790; FEH 417. 1966; EFPN 1: 79. 1978. *S. prolifera* Roxb., Fl. Ind. 3: 795. 1832, *p.p.*; FBI 6: 312. 1892. *S. ocreata* A. DC., Monogr. Phan. 1: 193. 1878. *S. roxburghiana* Wall. *ex* Hook.f., FBI 6: 311. 1892; BP 2: 1071. 1903.

Shrubby tendril climber. Tendrils simple, stipular, up to 10 cm long. Stem and branches stout, terete, with recurved prickles. Lamina broadly ovate-oblong or orbicular, margin entire, apex acuminate or cuspidate, base rounded, 3–7 costate, petiole up to 3 cm long, auricled. Inflorescence elongated umbellate raceme or whorled. Flowers dioecious; tepals 6, free, pale greenish or yellowish; stamens 6, filaments unequal, anthers oblong, 2-celled; carpels 3, ovary 3-loculed, ovules 1–2 per locule, stigmas 3, recurved. Berries globose, red when ripe.

Fl. & Fr.: April to December.

Local distribution: Darjeeling – rare; Kurseong, 1,550 m; Sikkim – rare; Yaksum, Gangtok, Rishi, 2,200 m.

General distribution: INDIA: Eastern Himalaya, Darjeeling, Sikkim, Arunachal Pradesh, Meghalaya, Assam, central and southern provinces; Nepal; Bangladesh; Myanmar; Indo-China; Southeast Asia.

Exsiccatae: Darjeeling: St. Mary's, Kurseong, in a rocky place, 1,548 m, 13.xi.2013, *Samanta* 59; Sikkim: Yaksum, growing close to a narrow waterfall among rocks, 2,200 m, 16.xi.2013, *Samanta* 310.

Discussion

The members of Smilacaceae are widespread in the tropical and subtropical parts of the world, and several species grow in temperate regions and at higher altitudes. They beautify the forest particularly with their attractive foliage showing prominent parallel venation. Like the family Cucurbitaceae among the dicotyledons, species of the monocotyledonous family Smilacaceae bear tendrils for climbing in search of better light at the crown of the trees in the forest (Samanta and Panda 2011). In Smilacaceae, the tendril is a modified stipule.

The present survey in Darjeeling and Sikkim Himalaya revealed eight species of the family Smilacaceae distributed between 110–3,200 m. *Smilax ovalifolia* occurs at low to medium-high altitude, i.e. 110–1,000 m; *Smilax aspericaulis* and *Smilax perfoliata* are distributed between 300–2,200 m; and *Heterosmilax japonica*, *Smilax aspera*, *Smilax ferox*, *Smilax glaucophylla* and *Smilax lanceifolia* grow between 1,500–3,200 m. Regarding frequency of each species in these hills, *Smilax ferox* is abundant; *Smilax aspera*, *Smilax aspericaulis*, and *Smilax ovalifolia* are quite common; *Heterosmilax japonica*, *Smilax glaucophylla* and *Smilax lanceifolia* are less common; and *Smilax perfoliata* is rare. Appropriate conservation measures are necessary to save particularly the less common / rare species from further loss of population.

In the family Smilacaceae, only *Smilax* species were so far reported from the state of West Bengal (Chakraverty *et al.* 1999); the present collection is the first report of the genus *Heterosmilax* from West Bengal.

Some *Smilax* species are useful to the locals in these regions, for example, the ripe fruits of *S. aspericaulis* are edible; the seeds of *S. ovalifolia* are used in the treatment of dysentery, abnormal discharge of semen, urinary infection, venereal diseases and rheumatism; the roots of *S. aspera* are prescribed in urinary and skin diseases. The data presented in this paper will be useful in updating the plant resources of the country.

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22. *DIGITARIA RADICOSA* (J. PRESL) MIQ. AND *PENNISETUM PURPUREUM* SCHUMACH. – ADDITIONS TO THE GRASS (POACEAE) FLORA OF MANIPUR, INDIA

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While working on the grass (Poaceae) flora of valley districts of Manipur, India, the first author collected two interesting specimens from Nambul river bank area. After critical morpho-taxonomic analyses and herbarium (CAL) consultation, they were identified as *Digitaria radicosa* (J. Presl) Miq. and *Pennisetum purpureum* Schumach. Perusal of literature (Deb 1961; Kabeer and Nair 2009, Khan *et al.* 2007; Shukla 1996; Singh 1987; Singh 1990; Sreekumar and Nair 1991) revealed that both the species were hitherto unrecorded from Manipur. These two species are reported here as new records for the flora of Manipur.

1. ***Digitaria radicosa*** (J. Presl) Miq., Fl. Ned. Ind. 3: 437. 1857; Veldkamp in Blumea 21: 35. t. 5b. 1973; S. Moulik, Grasses Bamboos India 1: 94. 1997; Sreek. & V.J. Nair, Fl. Kerala Grasses: 240. 1991; U. Shukla, Grasses N.E. India: 320. 1996; Kabeer & V.J. Nair, Fl. Tamil Nadu Grasses: 245. t. 47. 2009; *Panicum radicosum* J. Presl, Reliq. Haenk. 1: 297. 1830; *Digitaria timorensis* (Kunth) Balansa in J. Bot. (Morot) 4: 138. 1890; Bor, Grasses Burma, Ceylon, India & Pakistan: 306. 1960; *Panicum timorense* Kunth, Enum. Pl. 1: 83. 1833. *Paspalum sanguinale* Lam. var. *debile* Hook. f. in J.D. Hooker, Fl. Brit. India 7: 16. 1896. (Figs 1a–f).

Fl. & Fr.: September–December

Habitat: Commonly grows in moist open places of grasslands, river/pond banks, and cultivated fields.

Distribution: India: Andhra Pradesh, Bihar, Kerala, Maharashtra, Manipur (present report), Meghalaya, Nagaland, Tamil Nadu, Uttar Pradesh, West Bengal; Africa; Australia; China; Indonesia; Japan; Madagascar; Malaysia; Mauritius; Myanmar; Nepal; Pakistan; Philippines; Seychelles; Sri Lanka; Tanzania; Thailand.

Specimen Examined: Manipur, Imphal West district, Nambul river bank, Naoremthong, 24° 48' N, 93° 55' E, 769 m, 15.xi.2011, Coll.: K. Tilotama Devi 11115,

Fl. & Fr. Deposited at Herbarium of Department of Life Science & Bioinformatics, Assam University, Silchar.

2. ***Pennisetum purpureum*** Schumach., *Beskr. Guin. Pl.*: 44. 1827; Stapf in Kew Bull. 309. 1912; Bor, Fl. Assam 5: 298.1940; Bor, Grasses Burma, Ceylon, India & Pakistan: 348. t. 40. 1960; Blatt. & McCann, Bombay Grasses: 184. 1984; Sreek. & V.J. Nair, Fl. Kerala Grasses: 292. 1991; U. Shukla, Grasses N.E. India: 351. 1996; S. Moulik, Grasses Bamboos India 1: 140. t. 23. 1997; Kabeer & V.J. Nair, Fl. Tamil Nadu Grasses: 295. t. 55. 2009. (Figs 1g–k).

Fl.: November.

Habitat: Commonly found near river banks and streams.

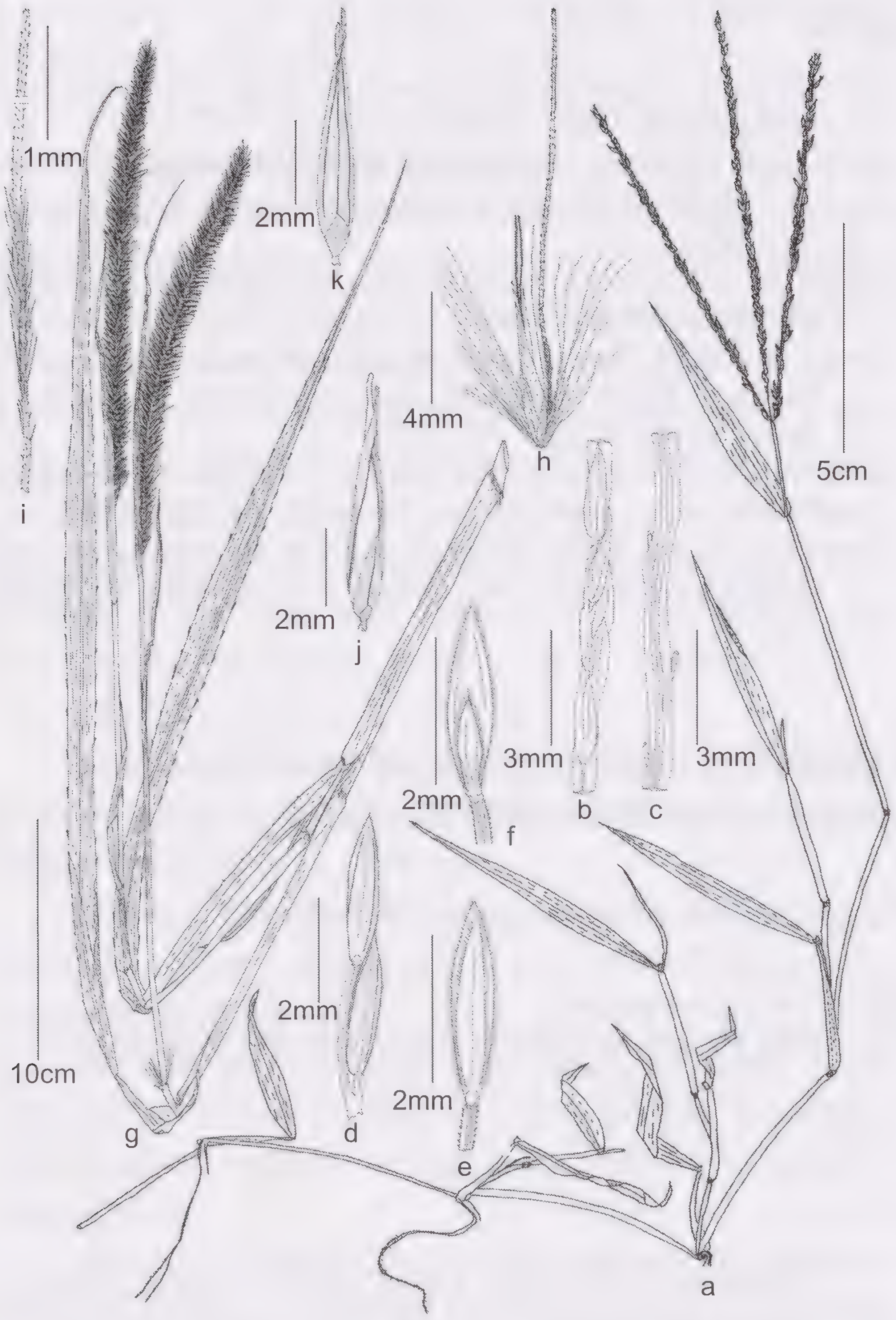

Fig. 1: *Digitaria radicosa* (Presl) Miq (a–f): a. Habit; b. & c. Rachis showing spikelet position; d. Paired spikelets; e. Spikelet showing lower glume; f. Spikelet showing upper glume *Pennisetum purpureum* Schumach. (g–k): g. Habit; h. Spikelet with bristles; i. Primary bristle; j. Spikelet showing lower glume; k. Spikelet showing upper glume

Distribution: INDIA: Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Delhi, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur (present study), Odisha, Tamil Nadu, Uttar Pradesh, West Bengal; Native of tropical Africa; introduced in many tropical countries; Bhutan; China; Taiwan.

Specimen Examined: Manipur, Imphal West District, Nambul river bank, Khagempali, 04.i.2012, Coll.: K. Tilotama Devi 11122, Fl. Deposited at Herbarium of Department of Life Science & Bioinformatics, Assam University, Silchar.

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23. *PTERIS BIAURITA* L. (PTERIDACEAE) – AN ADDITION TO THE FERN FLORA OF UTTAR PRADESH, INDIA

SHOBHIT KUMAR SRIVASTAVA[1,2], S. DOMINIC RAJKUMAR[1,3,*] AND SHASHANK KUMAR SINGH[1,4]

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Introduction

Pteris L. is a pantropical genus with about 280 species worldwide (Copeland 1947), 48 species (Dixit 1984), and 46 species (Chandra 2000) in India. 15 species are reported from Western Ghats, southern India (Manickam and Irudayaraj 1992), 14 species from Assam (Borthakur *et al.* 2001), and 14 species from Malabar region (Nayar and Geevarghese 1993). *Pteris biaurita* is a common species in Western

Ghats, southern India (Irudayaraj and Manickam 1995). During a recent exploration of Dudhwa National Park, Uttar Pradesh, the species was collected and found to be common throughout the Park. This note reports *P. biaurita* for the first time from Uttar Pradesh. Uttar Pradesh is bound by Nepal on the north, Uttarakhand on the north-east, Himachal Pradesh on the north-west, Haryana on the west, Rajasthan on the south-west, Madhya Pradesh on the south and south-west, and Bihar on the east.

Pteris biaurita L. Sp. P1. 2: 1076. 1753; Clark in Trans. Linn. Soc. Lond., II Bot. 1: 469. 1880; Walker in Br. Fern Gaz. 10: 149. 1970; Nayar & Kaur, Comp. Beddome Handb. 31. 1974; Dhir, Ferns N.W. Himal. 49. 1980; Baishya & Rao, Ferns and Fern Allies Meghalaya, 110. 1982; Dixit, Cens. Ind. Pterid. 69. 1984; Manickam, Fern F1. Palni Hills, 21. 1986; Jamir & Rao, Ferns Nagaland, 146. 1988.

Campteria biaurita (L.) Hook, Gen. Fil. t. 65 A. 1841; Beddome. Handb. Ferns Brit. India, 116. 1883; Holttum, Rev. F1. Mal. 2: 407. 1954.

Description (Fig. 1)

Rhizome erect up to 3 cm diameter, densely covered by scales at the apex, scales lanceolate, 3 x 0.75 mm, brown, translucent at the periphery, dark brown and opaque at the centre, apex acuminate, hairy margin. Stipe tufted, numerous, 36–71 cm long, 3–7 mm thick, pale brown at the base, abaxially rounded, adaxially grooved, scaly at the base, glabrous above. Lamina lanceolate, up to 71 x 40 cm, bipinnatifid; pinnae up to 12 pairs with one or two accessory branches on the basal basiscopic side of the basal-most pairs, subopposite, lanceolate, shortly stalked, apex acuminate, base broadly cuneate, margin lobed within 3 mm from the costa, lobes oblong slightly falcate, up to 3.3 x 0.8 cm, apex rounded, margin entire; veins distinct both above and below, basal veins of adjacent costule forming an arc along costa with five to seven excurrent veins passing to the sinus base, other veins forked once and reaching the margin; pinnae pale green; texture subcoriaceous; small spinule borne at the base of each costule. Sori borne all along the margin except at the base of the sinus and at the apex of the lobes; spores 47 x 47 μm, dark brown, exine with dense reticulate thickenings and winged perispore.

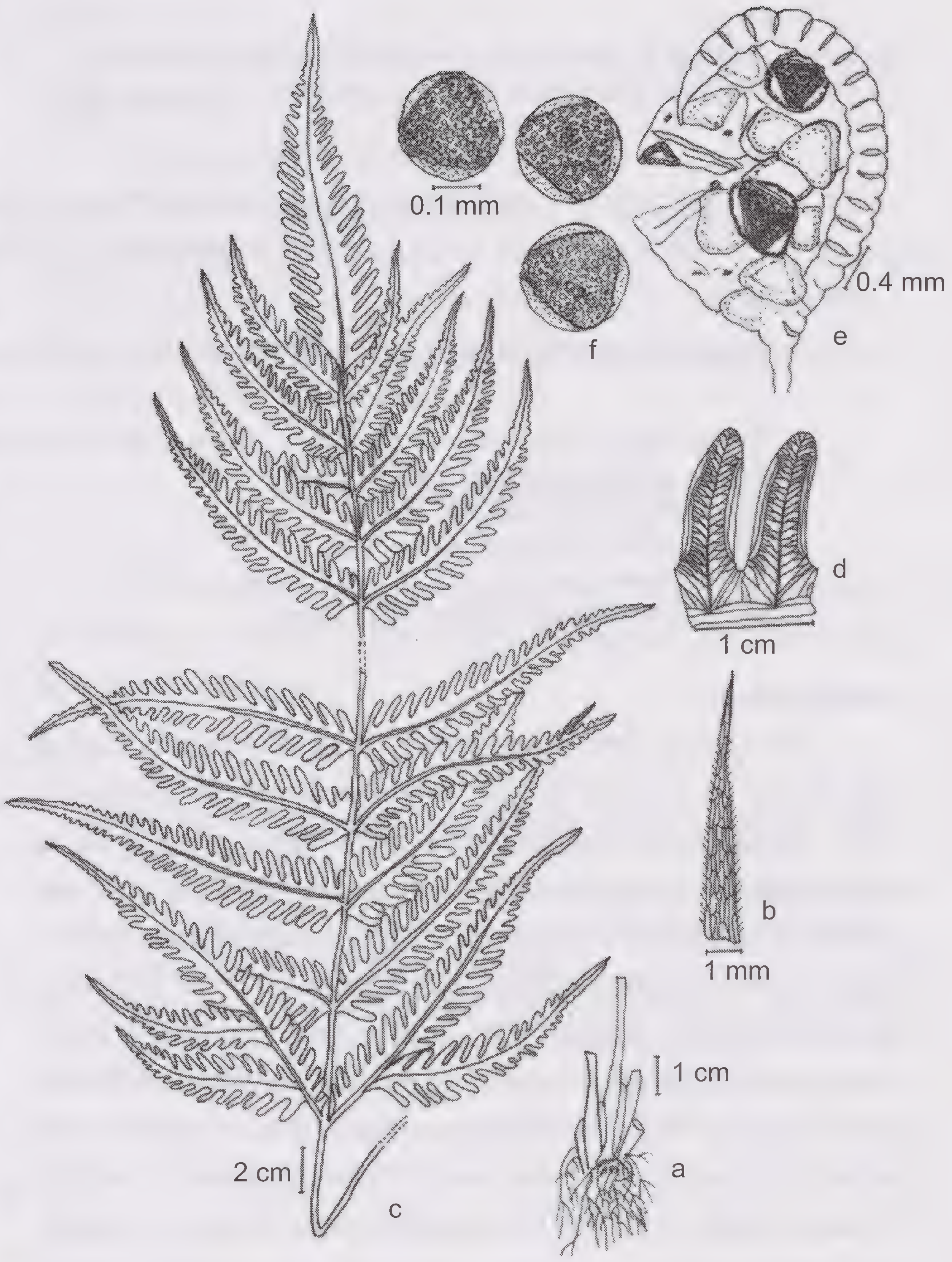

Fig. 1: *Pteris biaurita* L. a) Rhizome, b) Rhizome scale, c) Habit, d) Enlarged pinna showing venation & sori, e) Sporangium, f) Spore

Specimen Examined

Pteris biaurita: Dudhwa National Park – Lakhimpur Kheri, 16.x.2012, 160 m, SAC-415, SAC-450. All the specimens are deposited in Centre for Plant Species Biology, Department of Botany, St. Andrew's College (PG), Gorakhpur, Uttar Pradesh.

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24. NEW DISTRIBUTIONAL RECORD OF TWO SPECIES OF *OPHIOGLOSSUM* L. FOR THE DECCAN PENINSULA, INDIA

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Introduction

The genus *Ophioglossum* L. has 40 species and a few varieties known so far worldwide (Pichi-Sermolli 1958; Yadav and Goswami 2010). In India, the genus is represented by 12 species (Goswami *et al.* 2008). Manickam and Irudayaraj (1992) reported five *Ophioglossum* species from southern Western Ghats, and Bhuskute (1999) reported six species from Maharashtra. Since then, there has been no authenticated study on the genus *Ophioglossum*. While investigating the pteridophytes from Maharashtra, the authors collected eight species of *Ophioglossum*, of which *O. parvifolium* Grev. and *O. polyphyllum* A. Braun ex Seubert are reported as new records to the Deccan peninsula, India. The present note deals with taxonomic account, distribution, and phenology. A modified key to the *Ophioglossum* species, based on Panigrahi and Dixit (1969), is also given.

KEY TO SPECIES OF *OPHIOGLOSSUM* L. FROM DECCAN PENINSULA

1. Plants less than 10 cm 2
— Plants above 10 cm 5
2. Sterile lamina linear, grass-like .... *O. gramineum*
— Sterile lamina ovate-elliptic or elliptic-lanceolate 3
3. Rhizome subglobose, trophophyll ovate-elliptic 4
— Rhizome tuberous, trophophylls elliptic-lanceolate, apex acute .... *O. lusitanicum*
4. Trophophylls ovate or elliptic, apex obtuse, base cuneate .... *O. nudicaule*
— Trophophylls ovate, apex acute-apiculate, base cuneate .... *O. parvifolium*
5. Rhizome globose or bulbous 6
— Rhizome not globose 7
6. Sterile trophophylls small, lanceolate, obtuse-ovate .... *O. costatum*
— Sterile trophophylls large, elliptical-oblong, glabrous........ *O. polyphyllum*
7. Lamina cordate .... *O. reticulatum*
— Lamina lanceolate .... *O. petiolatum*

Ophioglossum parvifolium Grev. & Hook. Bot. Misc. 3: 218. 1833.

Terrestrial herb, height 4–5 cm; rhizome 3–4 mm diam., erect, soft, tuberous, bearing 1–2 trophophylls at the apex; trophophylls 0.4–1 cm long, 0.4–0.6 mm broad, ovate-lanceolate, apex acute to apiculate, margin entire, base cordate; veins obscure, four or five veins passing up through the stalk of the blade; fertile segment 2–4 cm long, linear oblong; strobili 0.5–1 cm long, 0.3 mm broad, 3–6 sporangia, alternate on either side; spores 25–45 µm diam., trilete, exine reticulate.

Distribution

World: India, China, South America, Sumatra, Malaysia, Thailand.

India: Madhya Pradesh, Gujarat, Maharashtra.

Maharashtra: Tableland plateau (Panchgani), Ghanbi, Radhanagari, Dajipur, Ajara, Tilhari Nagar, Achirne, Fonda.

Phenology: June–August.

Ecology: Common species, growing in patches on fully exposed plateaus at an altitude 200–1,200 m. The species is associated with *Ophioglossum gramineum*, *O. costatum*, and *O. nudicaule*.

Ophioglossum polyphyllum A. Braun ex Seubert, Fl. Azor. 17. 1844; Pichi-Sermolli, Webbia 9: 632. 1954; Panigrahi and Dixit, Proc. Nat. Inst. Sci. India 35 B(3): 255. 1969; Dixit, Indian Fern J.6: 146. 1989.

Ophioglossum cuspidatum Milde, Bot. Zeit. 22: 107. 1864;

Ophioglossum aitchisonii (Clarke) d' Almeida, J. Indian Bot. Soc. 3: 63 f. 12–13. 1922; Mahabale, Bull. Bot. Surv. India 4: 71. 1962.

Plant up to 15 cm long, terrestrial or semiaquatic; rhizome linear elongate, unbranched fusiform, bearing numerous fibrous rhizoids; trophophylls 4–12 cm long, 1–2 cm broad, tuft, elliptical-oblong, glabrous, narrowed at base and apex, wider medially, apex acute-mucronate, margin entire; texture herbaceous; veins without free endings, anastomosing with simple included veinlets; fertile segments 4–6 cm long without strobili, arising from the base of each sterile leaf under the soil; strobili 1–2.5 cm long, green when young, yellow at maturity; spores *c.* 30–40 μm diam., trilate with circular *amb.* and fine reticulated exine.

Distribution

World: India, Ethopia, Kenya, south-west Africa, North America.

India: Uttar Pradesh, north-east Himalaya, Maharashtra.

Maharashtra: Jat (Sangli district).

Phenology: July–October.

Ecology: Constrained to the ground and its adjoining grassland area at Raje Ramrao College, Jat, Sangli district, Maharashtra, India. Grows where the annual rainfall is below 1,000 mm at 700 m altitude.

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CONTENTS

EDITORIAL 71

MOLECULAR SEXING OF THE CRITICALLY ENDANGERED SLENDER-BILLED VULTURE *GYPS TENUIROSTRIS* AND ITS CONSERVATION IMPLICATIONS
Mandar Dilip Kulkarni, Rohan Shringarpure, Chandra Mohan S., Mohini Saini, Tapan K. Palai, Praveen K. Gupta, Purvi Bhatt, Nikita Prakash, Ashok Bhagwat and Vibhu Prakash 73

THE GRASSLAND BIRDS OF ROLLAPADU WILDLIFE SANCTUARY, ANDHRA PRADESH, INDIA, WITH SPECIAL REFERENCE TO THE IMPACT OF GRAZING-FREE ENCLOSURES
Ranjit Manakadan 81

FOOD HABITS OF INDIAN GREY HORNBILL *OCYCEROS BIROSTRIS* IN SATHYAMANGALAM FOREST DIVISION, EASTERN GHATS, INDIA
E. Santhoshkumar and P. Balasubramanian 90

NEW RECORD OF LIVE CORAL SPECIES COLONIZING INTERTIDAL ZONES ALONG SOUTHERN SAURASHTRA, INDIA
Paresh Poriya, Bhavik Vakani and Rahul Kundu 98

NEW RECORDS OF SEAWEEDS FROM THE GOA COAST, INDIA
N. Pereira and M.R. Almeida 106

REVIEW 124

MISCELLANEOUS NOTES 125

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VOLUME 111(3): DECEMBER 2014

CONTENTS

EDITORIAL 159

REOCCUPATION OF FORMER TERRITORIES BY THE ASIATIC LION *PANTHERA LEO PERSICA*, MEYER, 1826, IN SOUTHERN SAURASHTRA, GUJARAT, INDIA: A VISION FOR FUTURE MANAGEMENT
M.K. Ranjitsinh 161

BEHAVIOURAL ETHOGRAM OF SPOTTED OWLET *ATHENE BRAMA* (TEMMINCK, 1821)
Ashish N. Nerlekar, Gaurang G. Gowande and Pratik S. Joshi 172

TAXONOMIC STUDIES ON THE GRASSHOPPER FAUNA (ORTHOPTERA: ACRIDIDAE) RECORDED FROM PADDY FIELDS IN UTTAR PRADESH, INDIA
Md Humayoon Akhtar and Mohd Kamil Usmani 180

A REPORT OF EREBIDAE (LEPIDOPTERA: NOCTUOIDEA) FROM THE TAMIL NADU PART OF THE WESTERN GHATS, INDIA
K. Sivasankaran and S. Ignacimuthu 193

REVIEWS

1. SHIFTING GROUND: PEOPLE, ANIMALS, AND MOBILITY OF INDIA'S ENVIRONMENTAL HISTORY
Reviewed by Asad R. Rahmani 210

2. THE SONG OF THE MAGPIE ROBIN
Reviewed by Asad R. Rahmani 210

3. GREEN WARS: DISPATCHES FROM A VANISHING WORLD
Reviewed by Asad R. Rahmani 211

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MISCELLANEOUS NOTES

MAMMALS

1. Hanuman Langur *Semnopithecus dussumieri* feeding on the apical stem of *Euphorbia nivulia* at Mount Abu and Kumbhalgarh Wildlife Sanctuaries in Rajasthan, India
Satish Kumar Sharma and Vijay Kumar Koli 212

2. First record of Hodgson's Bat *Myotis formosus* Hodgson, 1835 (Chiroptera: Vespertilionidae, Myotinae) from the Western Ghats, India
Rohit Chakravarty, Shashank Dalvi, Vishnupriya Sankararaman and D.V. Girish 213

3. Endangered Ganges River Dolphin *Platanista gangetica gangetica* sighted in Rapti river, Balrampur district, Uttar Pradesh, India
Kamlesh K. Maurya, Dabeer Hasan and Mudit Gupta 214

4. A scientometric analysis of the trends of information dissemination on 'true albino' and 'white' mammals
L.A.K. Singh 216

BIRDS

5. Sighting of Indian Spotted Eagle *Clanga hastata* from Tal Chhapar Sanctuary, Rajasthan, India
Siddhesh S. Surve, Pramod Patil, Noor Khan and Sujit Narwade 220

6. Sighting of Rose-ringed Parakeet (blue) at Kachoriya nala from Rawatbhata, Chittorgarh district, Rajasthan, India
Charchit Jain, Akshun Gupta and Rimal Sudhindran 221

7. Slender-billed Babbler *Turdoides longirostris* in Rajiv Gandhi Orang National Park, Assam, India
Biswajit Chakdar, Manabendra Ray Choudhury, Panna Deb and Hilloljyoti Singha 222

8. Jungle Babbler *Turdoides striata* at Tanot in Thar desert, western Rajasthan: a range extension
Pramod Patil, Siddhesh S. Surve, Noor Khan and Sujit Narwade 224

9. Sightings of Buffy Fish-owl *Ketupa ketupu* and Mangrove Pitta *Pitta megarhyncha* in Sundarbans Tiger Reserve, West Bengal, India
Harkirat Singh Sangha and Sandeep S. Dhumal 225

10. Observations on bill deformities in three bird species from Maharashtra, India
R.V. Hippargi, P.M. Bolde, M.K.Rao, A.M. Bolde and S.A. Gaikwad 226

11. The Buff-bellied Pipit *Anthus rubescens japonicus* at Ranthambhore, Rajasthan, India
Harkirat Singh Sangha 229

REPTILES

12. Albino Common Trinket Snake *Coelognathus helena* (Daudin, 1803) from Udaipur, Rajasthan, Northwest India
Satish Kumar Sharma and Padam Singh Rathore 230

FISH

13. On a collection of fish from Manjaly – an estuarine area of the river Periyar in Ernakulam district, Kerala, India
M.H. Shyla and K.S. Jameela Beevi 231

14. Sexual dimorphism in a benthic fish *Oxyurichthys tentacularis* (Valenciennes, 1837), Gobiidae, inhabiting Ashtamudi estuary, Kerala, India
Remya Mohan and Sherly Williams, E. 235

INSECTS

15. A note on the occurrence of *Bindahara phocides* (Fabricius) (Lepidoptera: Lycaenidae) as a fruit borer of *Salacia fruticosa* Heyne ex Lawson at Peechi, Kerala, India
Revathy, V.S., George Mathew, N. Sasidharan and K. Muhammad Anaz 236

16. *Papilio xuthus* Linnaeus (Lepidoptera: Papilionidae) – a new record for India
Nosang Muringla Limboo 238

17. Geographical convergence patterns in the distribution of *Drosophila* species in Nagaland, a sub-Himalayan hilly state of North-east India
Bovito Achumi, Shridhar N. Hegde, Pardeshi Lal, Zevelou and Sarat Chandra Yenisetti 239

BOTANY

18. Present status of *Aldrovanda vesiculosa* L. in India
Sauris Panda 246

19. On the ecology and occurrence of *Aeginetia indica* L. and *Wrightia dolichocarpa* Bahadur et Bennet in southern Gujarat, India
S.R. Kshirsagar 247

20. *Croton hirtus* L'Herit. (Euphorbiaceae) – a new record for Karnataka, India
K. Gopalakrishna Bhat 248

21. *Eleocharis spiralis* (Rottb.) Roem. & Schult. (Cyperaceae) – a new record for Andaman and Nicobar Islands, India
A.N. Chandore, M.Y. Kamble and K.V.C. Gosavi 249

Cover Photograph: Shaggy Lady Slipper Orchid *Paphiopedilum hirsutissimum* By Isaac Kehimkar

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Editorial

Symbolism *par excellence*

Besides the national animal (Tiger) and national bird (Peafowl), each state in India has a state animal, state bird, state tree, and state flower. The species thus selected is either very rare or widespread or has sociocultural values. Another reason for picking up a species for this honour is to connect people with the species and its habitat so they will become interested in its protection. The state is expected to take measures for species survival – why would a government select a species to represent the state when it is not interested in its protection? Let us take some examples and see what the states are doing.

First let's consider globally threatened species. Great One-horned Indian Rhinoceros is the state animal of Assam and Great Indian Bustard is the state bird of Rajasthan. What a contrast in the action of the two states! While the rhino has risen literally from mud in the last 100 years, the bustard is going to dust in another ten years or less. In the early 1900s, it is said that there were less than two dozen rhinos left in the swamps and muddy grasslands of Kaziranga in Assam, thanks to poaching and hunting. Poaching is still a problem, but the rhino numbers have increased to more than 2,000 in Kaziranga. To accommodate this increasing number, the Assam government has increased the area of Kaziranga six times; as a result this famous Park now spreads to 849 sq. km. The Assam government has developed Rhino Vision 20:20 under which the state aims to increase the Great One-horned Indian Rhinoceros numbers to 3,000 by the year 2020. Besides Kaziranga, rhinos are found in Orang, Pobitora and Manas, and will be reintroduced in Laokhowa Burha-chapori Wildlife Sanctuary from where they became extinct in 1983. Every poaching case of rhino results in public outrage, and is discussed in the state assembly. Perhaps for no other species have public rallies been taken out for its protection. Children write poetry, make paintings, youngsters join cycle rallies, elders express concern in seminars, and media thrashes the government after every rhino death, sometimes even when the death is due to natural causes. Every Assamese is proud of the state animal. Posters of rhinos are present in many street corners.

Contrast this with the status of Great Indian Bustard, now the rarest bustard of the world. From many thousands, hundred years ago, the Bustard number has gone down to less than 150 individuals in 2014. Along with Macqueen's Bustard, Chinkara (state animal), and Sandgrouse, the Great Indian Bustard is extensively hunted by poachers and criminals, but no one has been prosecuted till now. The Desert National Park where the GIB, as it is commonly known, was found will be reduced by half to accommodate the mining and industrial lobby. *Project Bustard*, announced with fanfare by the previous Rajasthan government three years ago, has been thrown to dust by the present government. Diyatra Closed Area in Bikaner district has been dismantled, and I know some wildlife officers who have never visited it in their entire tenure of posting in Bikaner, although it is only 40 km from the state headquarters. The bustard is practically extinct in Diyatra region, once its stronghold in Rajasthan. No bird has been seen for the last five years. Similar is the fate of Sonkhaliya Closed Area in Ajmer district, where nearly 80 bustards used to be present in the 1980s – this year (2014) none were seen. In the Sorsan Bustard Area in Baran district, the last bustard died in the mid-1990s.

The Bustard story is repeated in some other states too. Kashmir Stag or Hangul is the state animal of Jammu & Kashmir. This subspecies of Red Deer was widespread in Himachal and Jammu & Kashmir – now no more. Between 160 and 170 deer cling to their last stronghold in Dachigam National Park in Kashmir. You will think that the state government must be doing everything to protect its state symbol. Far from it! A request to remove the intrusive Sheep Breeding Farm from the National Park has been under discussion for the last 30–35 years. The request to start a state-of-the-art Conservation Breeding

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Programme is pending for lack of funds and interest. We hear a lot of homilies from politicians, but ground action is lacking. While in Europe the Red Deer has made a comeback, and there are millions of them, our own majestic subspecies trots towards extinction.

Another species that will become extinct is the central Indian Wild Buffalo, the state animal of Chhattisgarh. While for other wild animals we may not be able to immediately point out their importance to the general public, the Wild Buffalo is perhaps one of our most important genetic resources. On one side we have enacted a strong National Biodiversity Act to prevent 'stealing' of our genetic resource and the government encourages scientists to map the gene pool of wild plants and animals. On the other side, there is a gene pool in the form of Wild Buffalo that is dying out due to sheer neglect and apathy. One would assume that the Agriculture Ministry and the Animal Husbandry Department would be interested to take up this issue as they benefit from genetic diversity – one cannot be more wrong. It is only the understaffed and demoralized Chhattisgarh Forest Department that is taking some measures to protect the last few herds of Wild Buffalo. Their Conservation Breeding Programme perpetually suffers from a resource crunch.

Fortunately, there are some success stories also. Barasingha, for example, the state animal of Madhya Pradesh has made a comeback. Like the Wild Buffalo of Chhattisgarh, it was widespread in central India, but poaching, so-called sport hunting and conversion of its grassland habitat, brought it to the verge of extinction. Less than 70 animals were left in the grasslands of Kanha National Park in the 1970s. Thanks to good research-based conservation actions, now the number is more than 600, and increasing. Similar is the well-known case of Asiatic Lions of Gir. It is too famous to be repeated here.

Asiatic Elephant, an iconic animal, is the state animal of three states: Jharkhand, Karnataka and Kerala, while Blackbuck is the state animal of Punjab, Haryana and Andhra Pradesh. All state animals or birds are not necessarily rare. For example, White-breasted Kingfisher is the state bird of West Bengal, while Indian Roller is the state bird of Andhra Pradesh, Karnataka and Odisha. Indian Roller was selected as it eats insects, and thus is considered 'a friend of the farmer'. But why the White-breasted Kingfisher, which is such a widespread bird in South and South-east Asia. Why not Masked Finfoot or Mangrove Pitta that is found in Sundarbans – the largest mangroves in the world?

Similarly, selection of state flower does not follow any pattern. While Uttarakhand has opted for the famous Brahma Kamal that grows above the tree-line from 3,000 m to 4,500 m, the Uttar Pradesh government has opted for Palash or Flame-of-the-Forest. Manipur is proud of its endemic Siroi Lily, confined to a small area. Gujarat has opted for Marigold, a religious symbol being the thought. Bihar also has Marigold as its state flower.

Declaring state species is fine, but it should not remain symbolic. If the species is rare, and many species are, the state should do everything to improve its status. Just declaring a state animal or a state flower and not doing anything is 'Symbolism *par excellence*'. Species cannot survive on symbolism – they need concrete actions on the ground!

Asad R. Rahmani

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REOCCUPATION OF FORMER TERRITORIES BY THE ASIATIC LION *PANTHERA LEO PERSICA*, MEYER, 1826, IN SOUTHERN SAURASHTRA, GUJARAT, INDIA: A VISION FOR FUTURE MANAGEMENT

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While the total lion population has increased by 27% from 2010 to 2015, the increase during the same period in protected areas is only 6%, but the increase outside of them is 126%. The total area of the Gir National Park and Sanctuary and the Girnar, Mitiyala, and Paniya sanctuaries and their environs, is approximately 1,900 sq. km, while the current landscape occupied by the Lion in Southern Saurashtra is about 22,000 sq. km. No large wild cat has affected reoccupation of its former habitat on such a scale, neither in Asia nor in Africa, in the last more than 50 years. An encouraging factor which will assist the lion reoccupation of former territories is the sense of tolerance and pride with which the local people view the arrival of lions in their neighbourhood. The fact that lions prey substantially upon nilgai which cause damage to agriculture, has helped in their acceptance by the local communities. However, public opinion can change if lions come in serious conflict with human interests. The authorities, therefore, must prepare a comprehensive prospective management plan, which would assist the lion to reoccupy suitable former habitats including the Barda landscape, allow movement of specimens to prevent in-breeding, as well as to safeguard the lions, their prey and their habitats.

Keywords: Gir, Girnar, Barda, Shetrunja Hill, Nes, Nilgai

On the kind invitation of the Chief Wildlife Warden of Gujarat, I participated in the quinquennial enumeration of the Asiatic Lion in Saurashtra, from May 1–6, 2015. Having participated as a schoolboy in the first enumeration of the lion in independent India, carried out by the Principal of my school Mr. M.A. Wynter-Blyth in 1950 (Ranjitsinh 1997), and having been involved with the conservation of the lion and its habitats over the decades, it was a most rewarding experience. The total count of the lion went up from 411 in 2010 to 523 in 2015, an increase of 27%. However, more significant than the gross increase in population is the spread in distribution, consequent to the reoccupation of part of its former range by the lion.

Following the merger of the princely states in 1948, the entire extant world habitat of the Asiatic Lion, in southern Saurashtra, came under one authority for the first time – the Government of the State of Saurashtra at the outset, followed by the Government of the State of Bombay and then of Gujarat.

Lions have always exhibited their propensity to travel distances and to occupy contiguous habitats, even if it involves traversing open terrain. After their numbers grew following the disastrous decline after the famine of 1899–1900, they started appearing in Mitiyala, then a part of the princely state of Bhavnagar, from 1917 onwards. The most assiduous duty assigned to the field staff of the princely state of Junagarh, which had the major population of the lion, was to prevent lions from straying out of the territories of Junagarh State into the neighbouring Kathi estates and thereby getting shot. In independent India too, the policy was that of containment of the lion within the precincts of the Gir Forest. With the establishment of the Gir Sanctuary in 1965, followed by the initiation of the Gir Lion Sanctuary Project in 1972 upon the promulgation of the Wildlife (Protection) Act of 1972, and finally the establishment of Gir National Park (NP) over a major part of the Sanctuary in 1975 and the relocation of over a hundred "maldhari nesses"[1], the conservation status of both the Gir and of the lion improved significantly. The lion population within the precincts of the Gir NP and Sanctuary attained its optimum levels and started straying out. Some animals moved eastwards into what was called Baroda Gir, east of Jasadhar, and Mitiyala became a permanent abode of the lion. However, the major diaspora occurred southwards along the coast, where the Forest Department had carried out plantation of casuarina trees, augmented and invaded by *Prosopis juliflora*. The lions that occupied these new territories, especially along the southern coast, mostly survived on livestock supplemented with Wild Pig and Nilgai and were, of course, a major source of man-animal conflict, and were themselves in danger of being eliminated because of their cattle-killing propensity. The standard practice then was to capture these "truant" lions and to bring them back for release into the Gir, resulting in intra-specific conflict, and, frequently, the death of the "salvaged" lions. Very frequently, these very same lions themselves dispersed out of Gir again. The authorities in charge were reluctant to address the reasons of and the remedies for the lion dispersal – that the Gir had reached the limits of its carrying capacity of lions and that the lions needed more *lebensraum* (living space).

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[1] Encampments of livestock owners

Like most democratic governments, the Government of Gujarat was reluctant to establish more protected areas or to enlarge existing ones. The Gir Lion Sanctuary Project entailing the shifting of the maldhari nesses and establishment of the Gir NP, had been initiated during the period Gujarat was under the rule of the Central Government. The then Administrator, Shri K.T. Satarawala, I.A.S, had a personal interest in the conservation of the Gir and constantly sought the advice of the Bombay Natural History Society and of the Director of Wildlife Preservation, Government of India, which I then was. The Girnar massif had the only outlying discrete lion population during the 1950 enumeration and it had gene-flow connectivity with the main Gir population, for the major part of the 20th century, which now unfortunately is curtailed due to the intensive land use in the intervening landscape. Yet Girnar became a sanctuary only as late as 2008 and Mitiyala in 2004 (Singh 2004), despite constant reminders from the Government of India and the conservation lobby.

During my first tenure as Director of Wildlife of India (1972–75), the Indian Wildlife Board, whose member secretary I then was, had debated the idea of a second home for the lion; the first attempt in the Chandraprabha Sanctuary of Uttar Pradesh having failed in the 1950s. A subcommittee had been formed to identify a second home, with the late R.K. Dharmakumarsinhji as the chairperson and I as the member secretary. I visited the potential sites identified – Jaisamand and Todgarh sanctuaries in Rajasthan and the Barda forest in Gujarat. I had recommended that the Government of Gujarat should consider Barda as a potential second home for the lion and that Barda should become a sanctuary. This was not accepted and indeed, Barda was not even established as a sanctuary till 1979. A coalition of two young male lions, locally called "belad", had marched on their own into the marshland and scrub of Mokar near Porbandar and indeed, were on the outskirts of Ranavav, just below the Barda Hills. They would surely have reached Barda and reoccupied the former domain of the lion after a lapse of 120 years. But they killed two valuable horses and in February 2003, were caught, brought back to the Gir and released near Kankai in the centre of the Gir, where they were promptly killed by the resident dominant male. It is ironical that the Government of Gujarat has now established, at considerable expense, a rehabilitation centre for the lion in the Barda Sanctuary and has already placed captive lions there, for release.

During the past decades, the Government of Gujarat has been receiving suggestions for the enhancement of the protected area adjacent to the Gir, to provide for the increase and the "spillover" of the lion population. I had been suggesting that the landscape being occupied by the march of the lions should be called the "brihad" (enlarged) Gir, jokingly suggesting that just as emperors in ancient India practised "ashwamedha" whereby the emperor's armies followed a wandering stallion of the emperor, claiming for the emperor all the territories that the horse traversed, the State Wildlife Department should practice "a sinhamedha" and claim all the territories that this animal emperor occupied! The State wildlife authorities were not unaware of the needs of the growing population of Gir lions. However, in any developing nation, and particularly so in India, significant progress in nature conservation, especially involving a change in land use, can only be achieved through political will and support. The requisite change in perception, priority, and practice came about in the past decade, especially when Gujarat came to realize that it may lose its "monopoly" over the lion, for which a second home was being readied in Kuno-Palpur sanctuary in Madhya Pradesh, at the suggestion of scientists from the Wildlife Institute of India. The urgency and importance of *in situ* lion conservation became even more evident after the Supreme Court order of 2013 directing the translocation of lion to Kuno-Palpur in Madhya Pradesh. The demand for a second home outside of Gujarat needed to be countermanded by the claim that the lion had itself occupied a number of "satellite" secondary homes around the Gir; that it was safe even from the threat of an epidemic in its current expanded range and that it was loved by the local people and was a part of their local culture and milieu, which they would be very loath to part with.

Both the lion and its habitat have greatly benefited by this change. The policy of lion containment within the Gir NP and Sanctuary (1,412 sq. km) morphed into Asiatic Lion Landscape (ALL) conservation, encompassing 22,000 sq. km, all in South Saurashtra. Girnar became a sanctuary at long last and Barda is being readied to receive lions (Gujarat Forest Department 2015), its control having been transferred to the wildlife wing of the State in 2013. Poaching of lion for commercial purposes in 2007 led to large scale recruitment of forest guards and other field staff, a novelty in India today. But perhaps the most significant *volte face* has been the change in the attitude of the local people. Retaliatory poisoning of lions to avenge the killing of livestock was not uncommon in the past. Not anymore. The proximity of lions, their presence on private land and indeed their predation of livestock are often viewed not just with indulgence, but with a sense of pride and of ownership. Compensation for livestock killed by lions is sometimes not claimed. *Vanyaprani Mitra* or volunteers from 300 villages and 14 other settlements help the Forest Department and provide information on the presence and movement of lions in peripheral areas of the Gir (Gujarat Forest Department 2015). Over 6,000 volunteers from across Gujarat wanted to participate in the lion enumeration of 2015. In an opinion poll survey carried out by a prominent newspaper some years ago, 97% of the people of Gujarat did not want the lions to be moved out of Saurashtra. Gujarat has achieved with the lion what the rest of India has not succeeded in doing vis-à-vis the tiger, in endearing the lion and instilling pride and a sense of possession of the lion, amongst the common man. Whether the lion goes to the Kuno-Palpur Sanctuary or not, despite the categorical order of the Supreme Court, is a moot point, but the purpose of securing the safety of the lion has been ensured. Gujarat till just a few years ago had the unique distinction of being the only political entity in the world which had both the lion and the tiger. It is unfortunate that since the last tiger disappeared from the Dang forest of south Gujarat, the State has spurned the suggestions of many, including mine, to bring back the tiger to Gujarat.

During my periodic visits since the 1970s, I have witnessed an improvement in the biota, especially of the ungulate population, in the Gir NP and Sanctuary. With the reduction and stoppage of grazing, the habitat has significantly improved. Nowhere in India can one find such a profusion of the banyan tree *Ficus benghalensis*. More aerial roots are reaching the ground now than before, because there is less nibbling by livestock. The population of wild pig *Sus scrofa* is less than it was in the 1950s, but the nilgai *Boselaphus tragocamelus* have increased and now appear to have stabilized their numbers along the periphery of the protected areas and have multiplied outside of them. Chital *Axis axis* have truly proliferated, especially in the last decade and it is heartening to see the increase of sambar *Cervus unicolor*. I was fortunate to see the rare and elusive rusty-spotted cat *Felis rubiginosa* for the first time in Saurashtra. What has apparently not increased is the cryptic four-horned antelope *Tetracerus quadricornis*, an animal in retreat throughout the country and which is ignored almost universally. The lion has become bold and diurnal for the past number of decades. However, there is a dramatic change in the behaviour of the leopard *Panthera pardus*. Renowned for its shyness and circumspection, the leopard in the Gir has not only become diurnal and can be seen even at midday, but uncommonly bold as well, which is proof of the safety of its past generations.

However, what were most revealing and interesting were the changes outside of the Park and sanctuaries. I was able to utilize my five day stay at Sasan Gir to traverse areas I had not visited for decades and some parts which I had never been to before – from Mangrol in the west to Bhavnagar in the east; from Visavadar and Krankach in the north to Jasadhar and Jamwala in the south. Over the years one had been receiving reports of the progressive colonization of past habitats by the lion. I was not aware of the extent and dimension of it till I saw it for myself.

The Paniya Sanctuary established in 1989 (Sandeep Kumar and Pathan 2015) and containing Charakio Dungar, the second highest peak in the Gir after Nandivelo and adjacent to the Kankai-Sap Nes forest tract, used to be overrun with livestock. It is a spectacular area now, greatly improved in habitat quality, with its resident lion population which we saw. The May 2015 enumeration showed 11 lions in Paniya Sanctuary and adjoining areas (Table 1).

We continued eastwards past Dalkhania to Krankach and Liliya into the *Prosopis* thickets lining the banks of the Shetrunji river, where we saw nilgai and a pride of lions near its kill of a bullock. The area is removed from lands under the control of the Forest Department and we asked the local people what they felt about the presence of lions in their vicinity. They replied that they had no objection to sharing the space with the large carnivore and indeed, some even stated that they were glad to have them. Lions did kill cattle they said, but they also controlled the nilgai population which raided their crops. The people only wanted quick compensation to be paid if there were cattle kills. This area showed 28 lions in the 2015 lion count (Table 4).

We saw lions in the Nani Vadal *vidi*[2], which is under the control of the Forest Department and with control over demographic impact, is now a fine lion habitat. We also saw chital and nilgai here. The 2015 enumeration showed nine lions in Nani Vadal.

Further eastwards, we saw chital and nilgai in Dhaulikui / Hippa Vadli and of course, the lions, which

Table 1: Distribution of Asiatic Lion in Gir National Park, Sanctuary and other areas in 14th Asiatic Lion Population Estimate 2015

S. No.	Areas	Total
1	Gir National Park & Sanctuary and adjoining areas	304
2	Girnar Sanctuary	33
3	Mitiyala Sanctuary	8
4	Paniya Sanctuary	11
5	South Western Coast (Sutrapada-Kodinar-Una-Veraval)	32
6	South Eastern Coast (Rajula-Jafrabad-Nageshree)	18
7	Savarkundla, Liliya and adjoining areas of Amreli	80
8	Bhavnagar district	37
	Total	523

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[2] Vidi : Grassland - scrub area

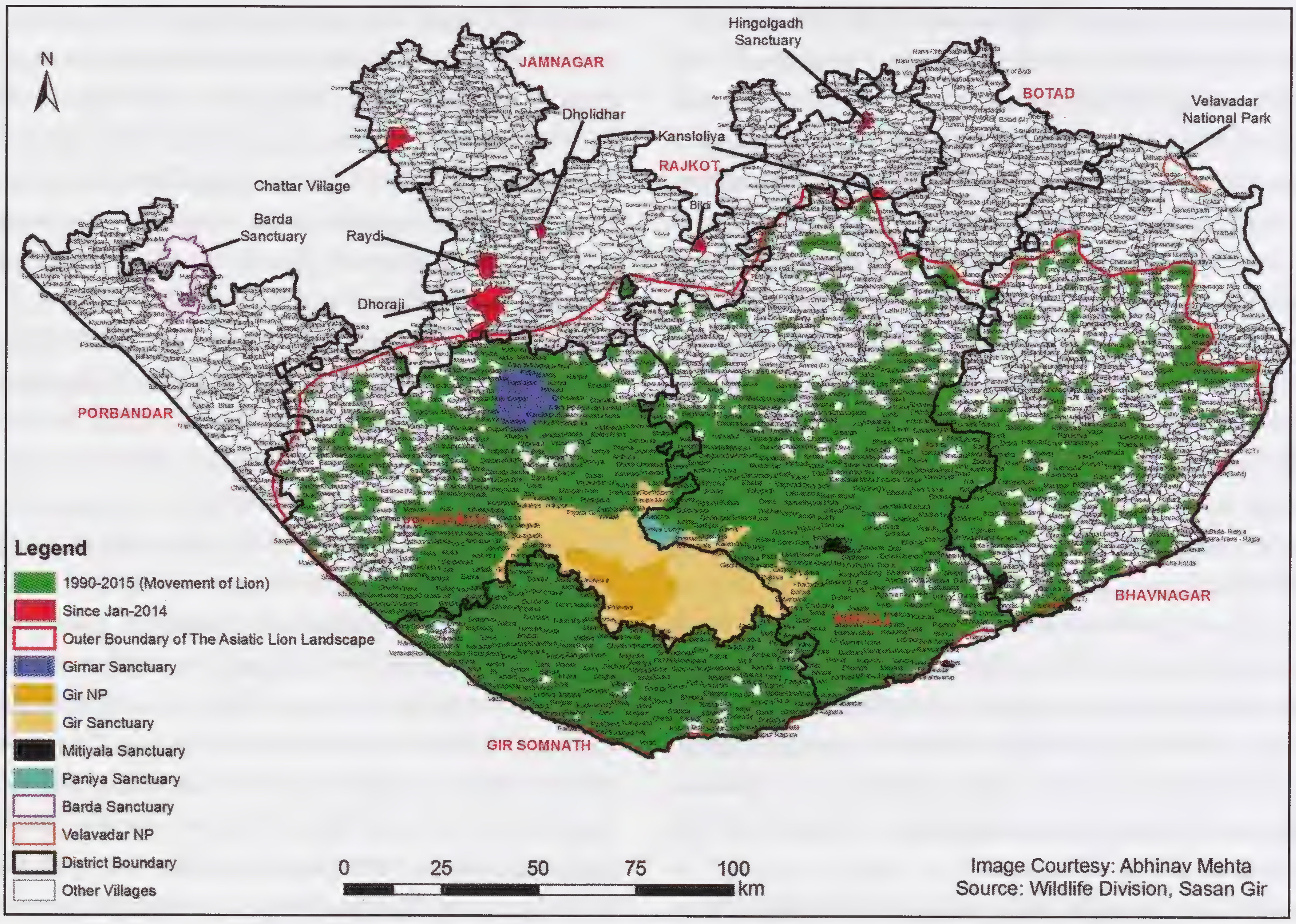

Fig. 1: Movement record of lions in the Asiatic Lion Landscape (ALL) outside of the Protected Areas

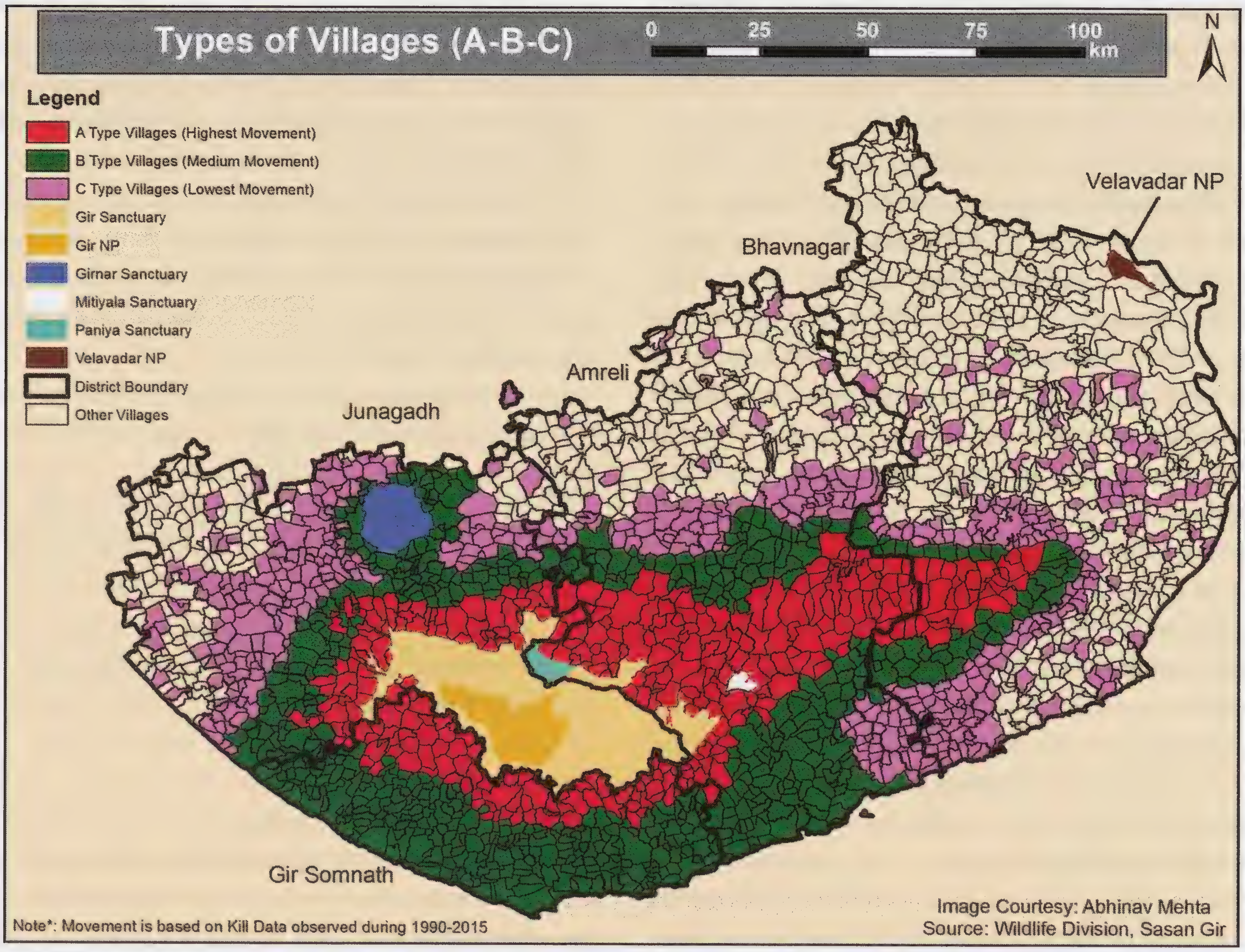
Types of Villages (A-B-C)
0 25 50 75 100 km
N
Legend
A Type Villages (Highest Movement)
B Type Villages (Medium Movement)
C Type Villages (Lowest Movement)
Gir Sanctuary
Gir NP
Girnar Sanctuary
Mitiyala Sanctuary
Paniya Sanctuary
Velavadar NP
District Boundary
Other Villages
Velavadar NP
Bhavnagar
Amreli
Junagadh
Gir Somnath
Note*: Movement is based on Kill Data observed during 1990-2015
Image Courtesy: Abhinav Mehta
Source: Wildlife Division, Sasan Gir

Fig. 2: Frequency of Lion visitation

Table 2: Comparison of population estimates in 2010 and 2015 (Inside and Outside PA)

Year	Inside PAs & adjoining areas	Outside PAs	Total
2010	337	74	411
2015	356	167	523
Difference	19	93	112
Percent growth	6%	126%	27%

Table 3: Villages in three districts having lion movement in Asiatic Lion Landscape

District	Total Villages in the districts	Villages having lion movement
Junagadh district	898	760
Amreli district	652	457
Bhavnagar district	832	258

have been resident here for the past some years. The habitat is also in a reasonably good state and there are shady nullahs with water to provide coolness and cover. The 2015 enumeration counted one lion in Nal. The narrow scrub forests of Sonsariyo provides safe link with habitats beyond. In Ranigala, we saw three more lions at the waterhole. There were 10 lions reported in this area in the enumeration.

From this area, the lions have marched eastwards through the *vidi*s and pastures of Jesar, Hathsani, Bodana, Vadal, Rajasthali, Kotiya, and Gebar to reach areas adjacent to the townships of Ghogha, Mahuva, and Talaja in southern Bhavnagar district. They had arrived in the Khokhra hills within sight of Bhavnagar city and had even reached the Chamardi hills within sight of Velavadar NP, before turning back (Fig. 1).

Southwards, the lion has taken up permanent residence in the coastal forests of Kodinar, Sutrapada, and opposite Diu Island. Westwards, lions now live close to Madhapur and Mangrol, where we saw footprints of a lioness in the impenetrable *Prosopis* thickets along the coast. Inland, in the Babra *vidi* we saw chital and close by in an orchard of the famous kesar mango, a lioness with cubs near its nilgai kill. The current enumeration showed a population of five lions for Babra *vidi* and its surrounds.

Northwards, lions have gone past Bagasara and Jasdan to reach the Hingolgadh Sanctuary, where a pregnant lioness took up residence for a period of time, their northernmost outpost after the 19th century, in Saurashtra. From Hingolgadh, the landmark hill of Chotila is visible and next to it lie the xerophytic forests of the Mandav hills, which are in sight of hills of the Rampara Wildlife Sanctuary in Wankaner, where a lion breeding and rehabilitation effort is already underway.

The enumeration of May 2015 revealed a remarkable fact, which perhaps has not received the attention that is due.

Table 4: Lion count in talukas outside PAs

Sr. no.	Place	Cubs	Subadult			Adult		Total
			Male	Female	Unidentified	Male	Female	
1	Bhesan	0	0	0	0	1	1	2
2	Mendarda	0	2	0	0	3	5	10
3	Mangrol	0	0	0	0	0	1	1
4	Malia	7	1	1	0	7	10	26
5	Visavadar	7	0	0	0	3	9	19
6	Una	2	1	1	0	1	6	11
7	Gir Gadhda	5	0	0	0	2	2	9
8	Kodinar	3	0	0	0	1	4	8
9	Savarkundla	0	0	0	0	1	0	1
10	Liliya	10	3	7	2	2	4	28
11	Rajula	3	0	0	2	1	3	9
12	Jafrabad	0	2	2	0	0	2	6
13	Bhavnagar	2	0	0	0	1	2	5
14	Gariadhar	0	0	0	0	3	3	6
15	Mahuva	2	1	1	1	6	7	18
16	Palitana	0	0	0	3	0	3	6
17	Talaja	0	1	0	0	1	0	2
	Total	41	11	12	8	33	62	167

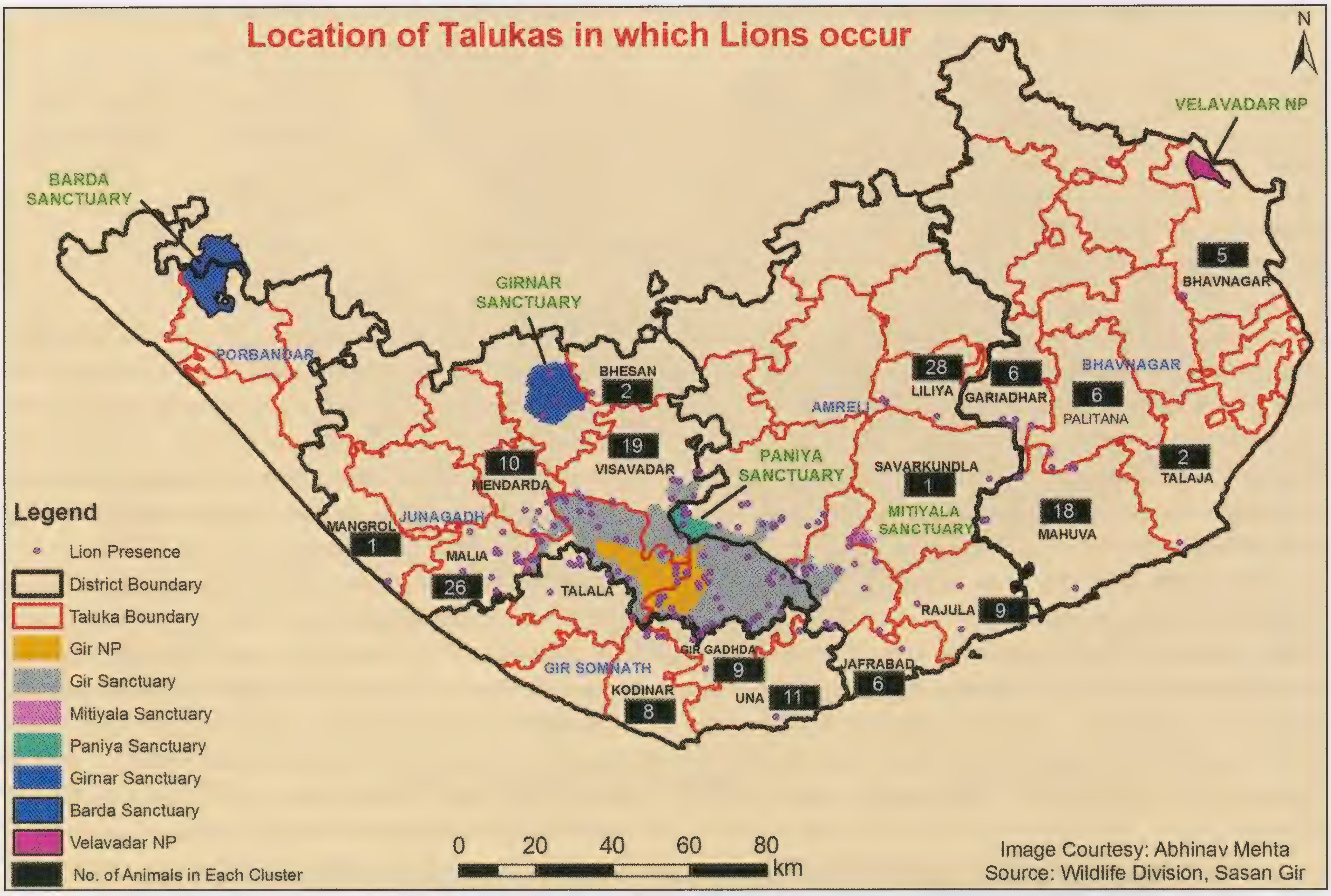

Fig. 3: Location of talukas in which lions occur outside of Protected Areas

The increase of the total lion population of 411 in 2010 to 523 in 2015 marked an overall increase of 27%. However, while the increase in the protected areas and their adjacent habitats (Gir NP and Sanctuary, and Girnar, Mitiyala and Paniya sanctuaries) was only 6%, proving that these protected areas and their adjuncts have reached the limits of their carrying capacities, the population in the areas outside of the protected area has increased by a startling 126% (Tables 1 and 2).

The range occupied by the lion has increased from approximately 1,900 sq. km (Gir NP and Sanctuary, Paniya, Girnar and Mitiyala sanctuaries and their environs and outlying outposts occupied earlier by lions along the southern coast of Saurashtra), to the current ALL admeasuring some 22,000 sq. km, as noted earlier (Figs 1 and 2). Though this entire area of 22,000 sq. km is not occupied, lions have taken up residence in a substantial number of contiguous habitats and even isolated outposts far removed, within this ALL. A substantial number of villages in the adjoining districts of Junagadh, Amreli, and Bhavnagar have had lion visitation or continuous occupation, some far removed from the protected areas (Figs 1–3; Table 3). No large wild cat has reoccupied its former habitat on such a scale, neither in Asia nor in Africa, in the past 50 years and more. It is a pronounced *ghar wapsi* (return to homeland) of the Asiatic Lion! In comparison, the tiger occupancy in the country shrank by almost 12,000 sq. km between 2006 and 2010, from 93,647 sq. km when their number was estimated at 1,411, to 81,906 sq. km when their population was believed to be 1,706. In the 2014 enumeration, the tiger population was estimated at 2,226, but the total range was reckoned as 92,154 sq. km, still over 1,500 sq. km less than the range in 2006 (Jhala *et al.* 2015).

Success demands a price. The protected areas, as noted earlier, have already reached the limits of their carrying capacity for lions. It is the exponential increase outside of the protected areas that has to be provided for, and plans prepared and implemented for the further increase in numbers and the consequent occupation of additional lands, in the decades to come.

Three important factors that will greatly facilitate this task of preparation for further occupation of former territories by the lion need to be noted. Firstly, the natural prey base of the lion has also appeared in most of the lands reoccupied by the lion. Apart from the wild pig, nilgai has helped in the dispersal of the lion (Fig. 4). It is pertinent to note that in the Gir NP and Sanctuary, which comprises the Forest Divisions of West Gir and East Gir, nilgai was found

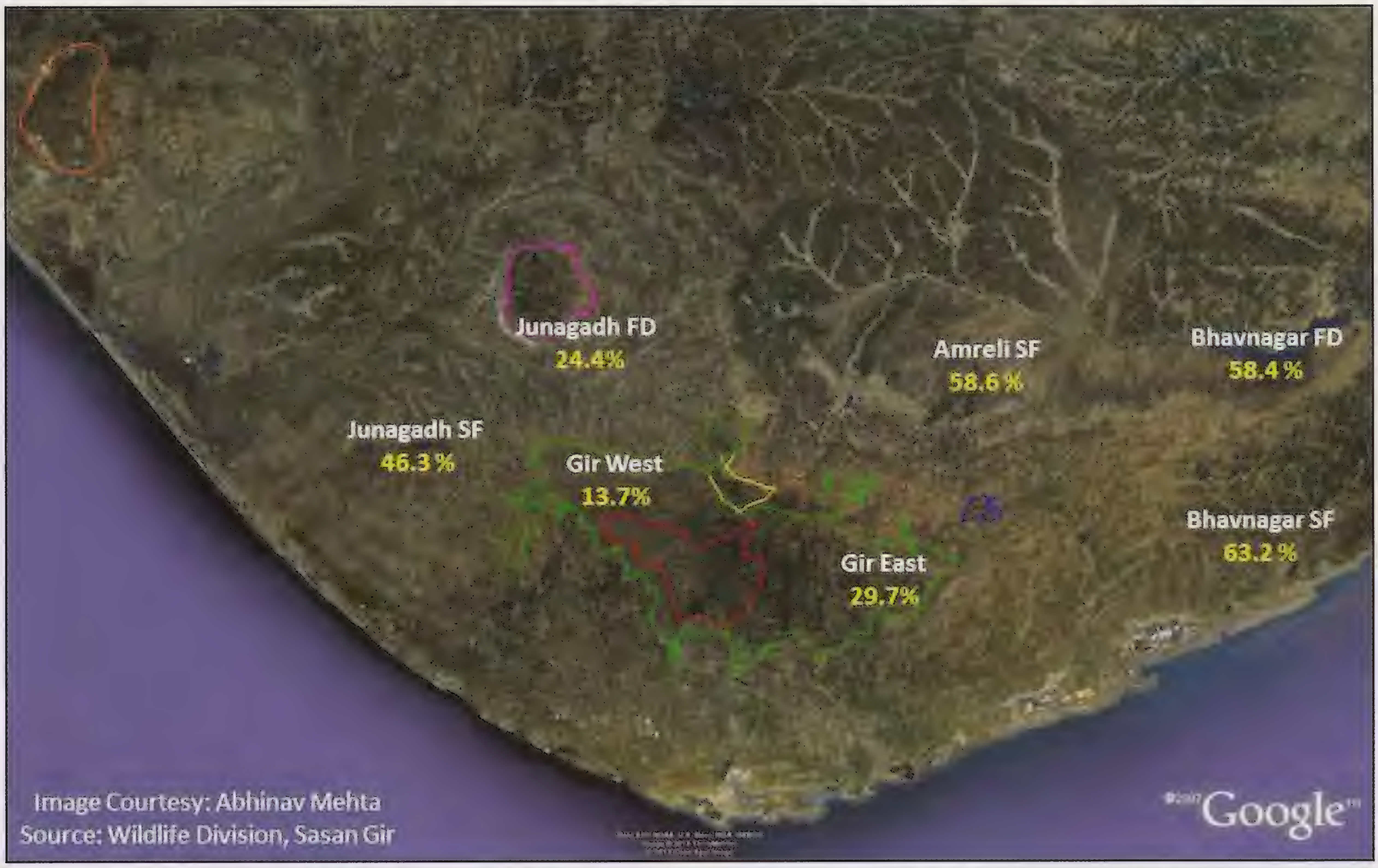

Image Courtesy: Abhinav Mehta
Source: Wildlife Division, Sasan Gir

Fig. 4: Percentage occurrence of Nilgai in scat analysis of Asiatic Lion in Asiatic Lion Landscape

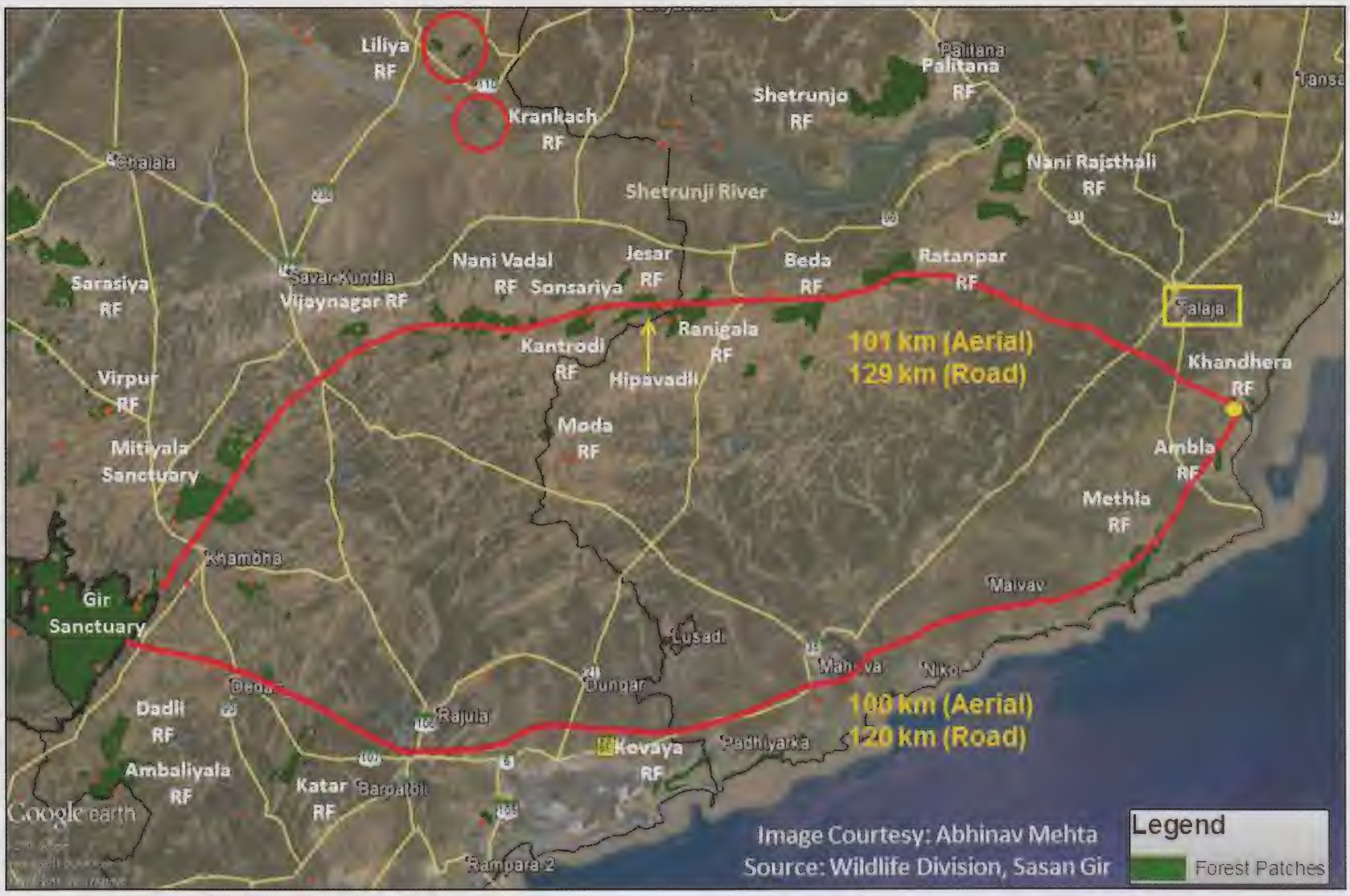

Image Courtesy: Abhinav Mehta
Source: Wildlife Division, Sasan Gir

Fig. 5: Movement along eastern corridors

to comprise only 13% and 29.7% respectively, of the lion kills located. The antelope does not prefer dense forest and the presence of other prey in these protected areas accounts for this low percentage. It is pertinent that within the Gir NP and Sanctuary, the eastern Gir, which is drier and has more open forest and supports a larger nilgai population and less chital and sambar, recorded more than double the percentage of nilgai kills than in the more forested western Gir. Outside of the PAs, where wild pig was the only other wild prey in most places, nilgai formed 58.4% of the kills located in the Bhavnagar forest area and, 58.6% in the Amreli, and 46.3% in the Junagarh Revenue areas, respectively. Considering the quantum of domestic livestock available and the ease with which it could be killed in these areas outside of the PAs, the preponderance of nilgai kills is remarkable and has greatly facilitated the dispersal of lion, while at the same time reducing the antipathy of local population, which would obviously have been enhanced had there been more kills of livestock. Chital have occupied a number of the lion outposts, travelling over agricultural areas and human habitations in the process. This simultaneous colonization by the chital is very significant and important from the viewpoint of reduction in man-animal conflict. For, while both wild pig and nilgai can take up residence in human habitats and agricultural fields, to pursue which the lion has to move in these tracts and thereby come in contact with livestock upon which it preys, the chital is confined to forested tracts. The chital, therefore, will help keep the lions in forested terrains and away from demographic contact. chital are also prolific and can provide a significant quantum of food to the lions in their new colonies, as they already do in the protected areas.

The second factor is the distinct improvement in the foliage, grass and biota in general in the habitats recently occupied by the lion, an obvious outcome of the greater protection that they have received since the lions arrived, together with the greater reluctance of the local populace to graze their livestock in these areas after the arrival of the lions. This improved cover will give shelter to both lions and their prey, thus preventing them from straying into human-occupied territories. It will also provide more natural resources to the local populations and help the water regimes.

Thirdly, the people around the areas recently colonized by the lions are not averse to the new arrivals. Some have welcomed them. The majority look upon the lions with equanimity and tolerance, indeed, with some degree of pride, as mentioned before. This is a very positive factor which bodes well not only for the survival of the present lion colonies, but for their further expansion in the future. The state authorities have their task greatly facilitated by this liberal outlook of the local people. However, they need to generously and expeditiously compensate for any livestock killed by lions.

The state authorities need to develop a master plan for the conservation of the current colonies of the lion outside of the protected areas. In this regard, the upgradation of the status of the habitat has to be considered. Ideally, some of the major outposts like Hippa Vadli / Malia which has a population of 26 lions, Babra and Mendarda to the west of the Gir Sanctuary having 10 lions, and parts of Visavadar which has 19 lions and Una in the south-east having 11 lions, should be declared as sanctuaries or conservation reserves. Other areas having lion populations in double figures, namely Liliya (28 lions) and Mahuva (18 lions) are mostly not under the direct control of the wildlife authorities and are surrounded by human habitations. These should become conservation reserves or community reserves under the aegis of the Wildlife (Protection) Act of 1972. The particulars of the 167 lions found in talukas outside of the protected areas in the enumeration of 2015, are given in Table 4.

The extended habitats actually occupied by the lion as currently confirmed in the 2015 enumeration is estimated as 285 sq. km (Table 5). Of this, 37 sq. km is forest land which can readily be declared as sanctuaries or conservation reserves. Non-forest government wasteland, which would be under the control of the Revenue Department of the state, extends to 93 sq. km, which could be designated as conservation reserves. For the remainder, comprising privately owned "maliki" land and "gauchar" or grazing lands, efforts can be made to establish community reserves for the lion. In any case, these entire tracts covering 285 sq. km should be declared as eco-sensitive zones forthwith.

A prospective management plan would not only require to give details of future management of the lion, its prey species and habitats recently occupied, but would also have to project the areas that are adjacent to the territories now occupied and where the lion is expected to move in the forthcoming decade. The plan would, therefore, have to envisage the present and future requirements of current

Table 5: Details of extended habitat for Lion

Status	Area in Ha.
Government Wasteland	9364.48
Gauchar Land	1767.8
Forest area	3734.68
Maliki Land	13665.42
Total Area	28532.38
	Say... 285.32 sq. km

* Note: The potential area of 285 sq. km. comprises 31 Villages of 4 Talukas

habitats outside of the PAs as well as of areas which the lion is expected to colonize in the coming decade. The protective staff and the basic infrastructure required would have to be put in place in the immediate future, so that the future habitats could be effectively protected and made ready to receive the lions in the coming years. The prospective plan, therefore, should combine a vision and a practical roadmap for the future conservation of the lion, its prey and of the ALL.

These conservation plans will have to be site specific and would need to be revised every two years. It will obviously have to emphasize on the conservation of specific corridors, perhaps the most important being the linkage connecting in the east Liliya, Krankach, Nanivadli, Hippavadli, Ranigala, Savarkundla, Shetrunja, and Sihor and connecting this axis with another further south – Una, Kodinar, Rajula, Mahuva, and Talaja (Fig. 5). The other most important corridor to be maintained and augmented is the link between the Gir and the Barda, via Babra, Malia, Mangrol, Madhapur, Mokar, and Ranavav (Fig. 6). Connecting Barda with Alech is another possibility.

The management of the Barda landscape, which includes the Barda Sanctuary and the Alech and Dalasa hills as a composite entity, would be of great significance (Fig. 7). Barda is not only an ecological entity by itself, but can also provide a separate viable population of the lion, which would be distinct from the Gir and Girnar and form a second home for the lion in Gujarat itself. In this regard, therefore, it is ecologically a more important alternative habitat for the lion than the Girnar and is of course, much larger. While efforts must be made to allow movement of the lion between Girnar and Barda, the linkage with the Gir via Mangrol – where they already are – is a more viable route at present (Fig. 6), as was attempted by a pair of males mentioned earlier. A small pride of wild lions can be translocated and rehabilitated in Barda. Needless to say, Barda needs urgent and active management to make it ready to receive the lions, as its prey base is as yet inadequate. Efforts should be made in the entire lion landscape to eliminate free-ranging dogs, as they are the carriers of deadly diseases such as canine distemper and rabies, and they are today major predators of wild ungulates which are the prey of lions. The ongoing chital reintroduction needs to be accelerated. The Maldharis from Barda also need to be relocated and they appear to be ready to go, as they themselves approached the author in this regard three years ago.

From where they are today, the lions are within easy

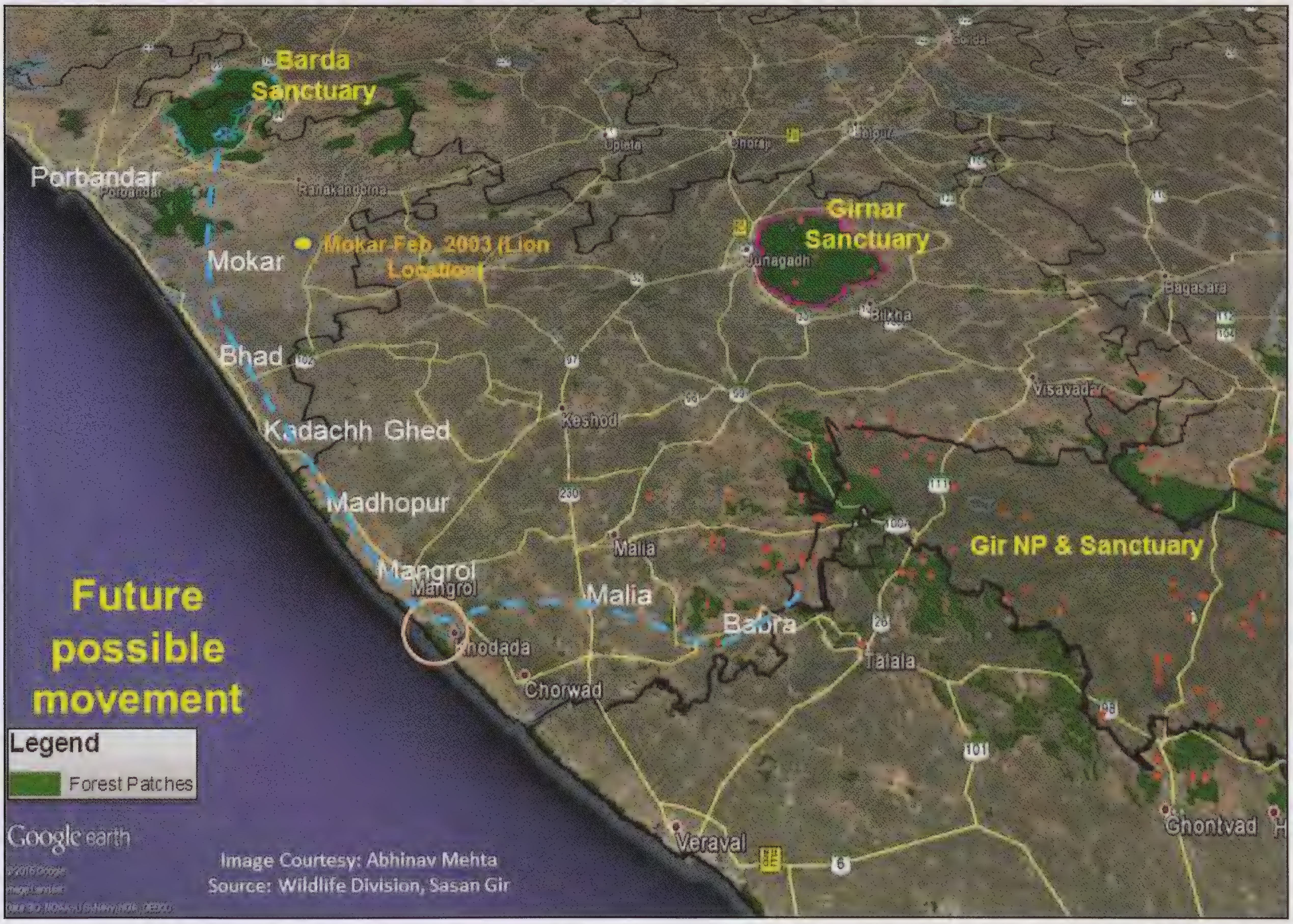

Image Courtesy: Abhinav Mehta
Source: Wildlife Division, Sasan Gir

Fig. 6: Future lion movement locations in Western Saurashtra landscapes

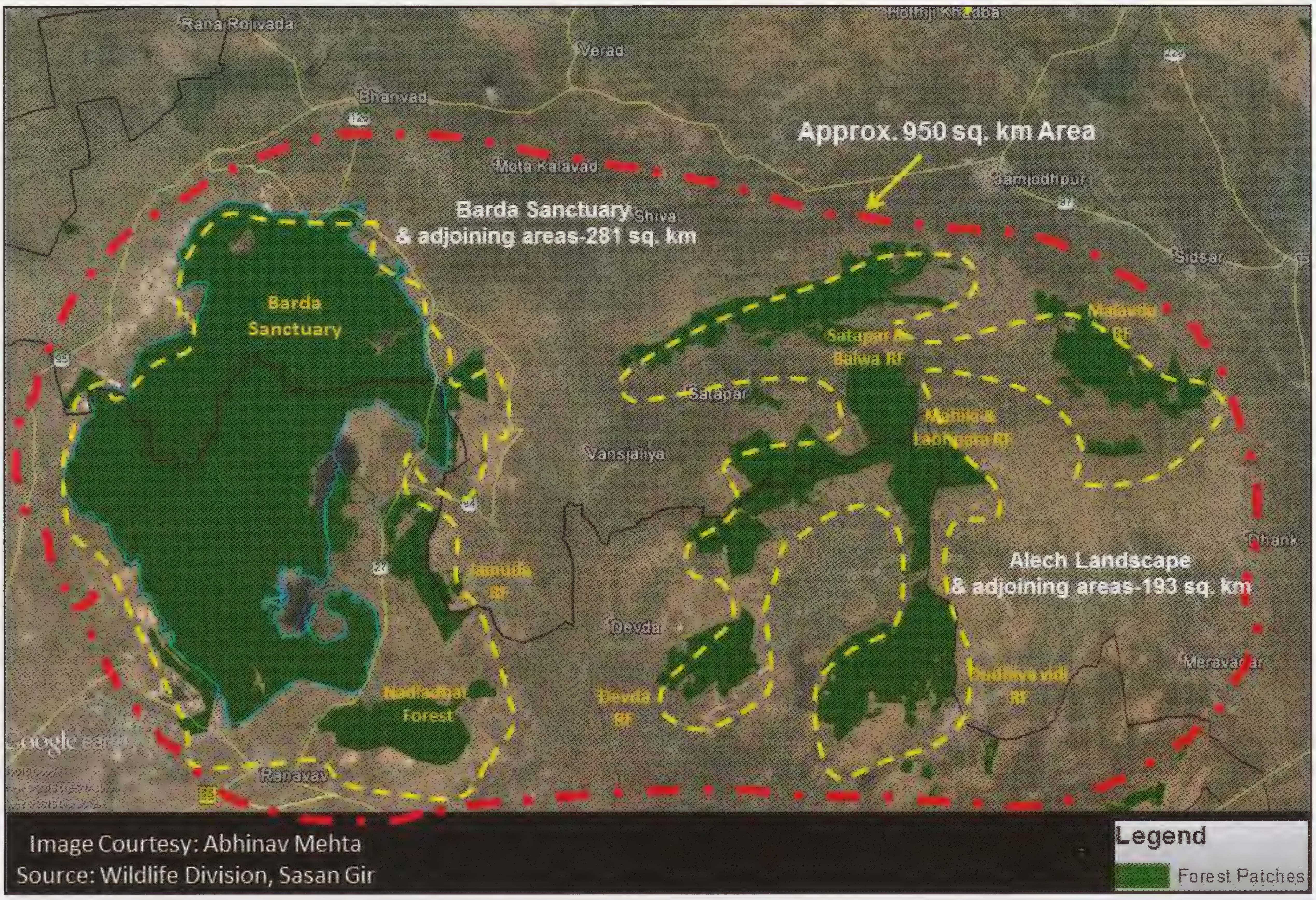

Image Courtesy: Abhinav Mehta
Source: Wildlife Division, Sasan Gir

Fig. 7: Barda-Alech landscape

reach of two former habitats, which are landmarks and which can be regarded as the eastern limits of their habitat in southern Saurashtra – the iconic Shetrunja massif (Fig. 5) sacred to the Jain community and the Sihor Hills eastwards, which was their abode a century and a half ago. For the movement to Shetrunja, the outlying hills of Kadam Giri and Hasta Giri need to be safeguarded and a sanctuary established to protect them adequately. Within the Shetrunja massif, the valley of Garmara on the western side of it would need special attention. Further north and east of Shetrunja and Sihor lies heavily inhabited level land intensively cultivated and a further march of the lion beyond these outposts is not advocated, though it may be tempting to envisage their reaching the Velavadar NP in the Bhal and the *Prosopis* thickets of Nari near Bhavnagar. Conflict with man, however, will be intense in the Bhal, from Nari to Velavadar. Sihor Hills and its forests can, however, sustain a small, stable lion population if the prey base can be built up. As the area is owned by the government, it should be declared as a sanctuary.

It is crucial to prepare for and facilitate the future colonization of the lion as mentioned above. If it is not implemented, the present colonies will become isolated and insular, resulting in an increasing conflict with man, especially as lion numbers grow in these current colonies. They cannot be translocated back to the Gir, as that would only be consigning them to death or disability. A long genetic isolation of these outlying populations could result in an inbreeding depression. Though at present the males in these outlying areas travel huge distances, for once they have mated with the few females in these scattered populations, they are compelled to move afield to look for lionesses in estrus elsewhere and are, therefore, themselves the agents of lion colonization. The Asiatic Lion has undergone genetic "bottlenecks" in the past (O'Brien 2003), with the last notable population depression occurring around the turn of the 20th century. If further isolation results and the animals occupying the scattered outposts of today become relict populations losing intra-specific contact, it is possible that inbreeding will lead to genetic deficiencies. The author saw a young male lion in Ranigala which appeared to have a defective backbone. Its movements were laboured and it needed to rest repeatedly. It was surviving because the other members of the pride were able to kill. The forest staff informed the author that this particular animal was born with the defect, which could be a manifestation of inbreeding, though the author had no means of ascertaining the real cause for the deformity. As compared with the sex ratio in Gir,

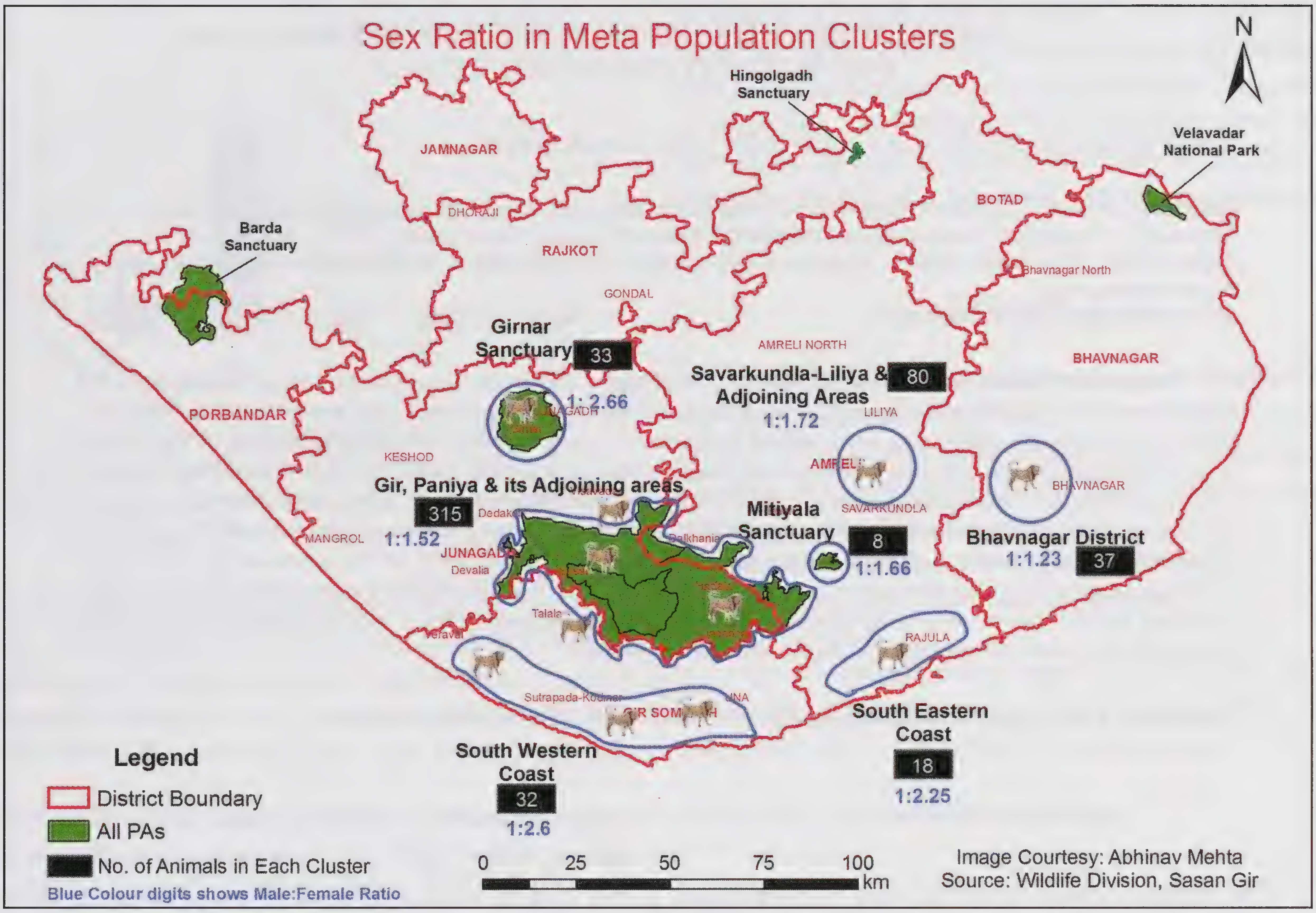

Fig. 8: Sex ratio in meta-population clusters

Paniya and Mitiyala Park/Sanctuaries all contiguous with each other, that of the lions in the more isolated outlying areas of Girnar, south-western and south-eastern coasts show a skewed sex ratio with far fewer males (Fig. 8).

It is imperative, therefore, that contiguity of habitats and the quality of the corridors are assiduously protected and maintained and the lions encouraged to move along them to ensure gene-flow connectivity. This could also encourage the surplus population of males from the periphery of the Gir NP and Sanctuary and from Paniya and Mitiyala adjacent to them, to move to the outlying colonies, thereby reducing conflicts and casualties amongst the males in these protected areas, as well as reducing lion infanticide. It may also lessen to some extent the mismatch in the sex ratios in the protected areas and outside of them, as conveyed in Fig. 8.

Mitigation of man-animal conflict, research and monitoring, and the inculcation of nature education and awareness amongst the people surrounding the current and prospective lion habitats, will have to be other important, integral components of the future management plan of the lion meta-population in the ALL.

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BEHAVIOURAL ETHOGRAM OF SPOTTED OWLET *ATHENE BRAMA* (TEMMINCK, 1821)

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The Spotted Owlet *Athene brama* is a common nocturnal raptor widely distributed in the Indian Subcontinent and neighbouring regions. Though subject to some studies, there is only fragmentary data available on its behaviour. Hence, we undertook a study in an urban habitat to construct a comprehensive behavioural ethogram of the species. A pair of Spotted Owlets with two juveniles was observed near their nesting site in the Fergusson College campus, Pune. Following the focal animal sampling method, the owlets were observed for 303 hrs (89 nights during pre-mating and mating, and 214 nights during post-mating periods). A total of 34 behaviours were compiled and classified into 10 functional groups, and a maximum number of behaviours (11) were recorded for the functional group Comfort and Maintenance. Out of the 50 mating/mounting events observed, 12% (n=6) involved ritual feeding before mating/mounting, and 88% (n=44) were direct mounting/mating instances. The availability of baseline information that defines each behaviour would be important for further quantitative studies.

Key words: Spotted Owlet, *Athene brama*, ethogram, Fergusson College, urban landscape

INTRODUCTION

The Spotted Owlet *Athene brama* is a nocturnal owl, widely distributed in the Indian Subcontinent and neighbouring regions (Ali 2002; BirdLife International 2014). It has been the subject of several ecological studies. General descriptions of the species are available in Ali and Ripley (1983) and Rasmussen and Anderton (2005). Kumar (1985) provides a comprehensive monographic work on its life history. The diet has been well-studied by Beg *et al.* (1990), Jain and Advani (1983), Jadhav and Parasharya (2003), Nerlekar *et al.* (2014), Pande *et al.* (2004), Santhanakrishnan *et al.* (2011a), Shah *et al.* (2004), and Zade *et al.* (2011). Studies regarding the breeding biology were carried out by Mahmood ul Hassan (2008), Peppe (1962), and Santhanakrishnan *et al.* (2011b). Roosting/nesting were studied by Currie (1916), Jadhav and Parasharya (2003), Kler (2005), Kler and Kumar (2012), Pande *et al.* (2006), and Santhanakrishnan *et al.* (2010a). The demography and perches were examined by Santhanakrishnan *et al.* (2010b) and Ali and Santhanakrishnan (2013) respectively. Some studies on physiology were made by Kumar and Ramana Rao (1984), Sudhakumari and Haldar (2001), and Pande *et al.* (2005).

Multiple ethological studies have been carried out on various species of: Flammulated Screech Owl *Otus flammeolus* (Marshall Jr. 1939), Saw-whet Owl *Cryptoglaux acadia* (Santee and Grenfield 1939), and Florida Burrowing Owl *Athene cunicularia floridana* (Mrykalo 2005). As for Indian species, Indian Eagle-Owl *Bubo bengalensis* (Ramanujam 2003, 2007, 2010) and Forest Owlet *Heteroglaux blewitti* (Ishtiaq and Rahmani 2005; Jathar and Rahmani 2004, 2011) have been studied for their behavioural ethogram. However, despite being a common species, only fragmentary data is available on the behavioural aspects of the Spotted Owlet (Allen 1920; Brahmachary *et al.* 1972; Gupta 1966; Jadhav and Parasharya 2003; Jose 1964; Kumar 1985; Mahmood ul Hassan 2008; Nilakanta 1972); the present study was undertaken to address this lacuna.

MATERIAL AND METHODS

Fergusson College is located in Pune, Maharashtra. The campus houses century old Gothic style buildings, and an array of exotic and indigenous plants. The B.J. Wadia Library is located in the central part of the campus, north of the main building (18° 31′ 17.75″ N; 73° 50′ 20.17″ E). The Spotted Owlets that were monitored had a known roosting site on a wooden ledge on the eastern side of the library, 10 m from the ground, just below the tiled roof of the building.

A pair of adult Spotted Owlets and two juveniles (*c.* 20 days of hatching) were monitored from April 01, 2012 to October 31, 2012 (214 days) during the post-mating period. The same pair (presumably, as it frequented the same roost site) was again monitored from February 01, 2013 to April 30, 2013 (89 days) for observations during courtship (pre-

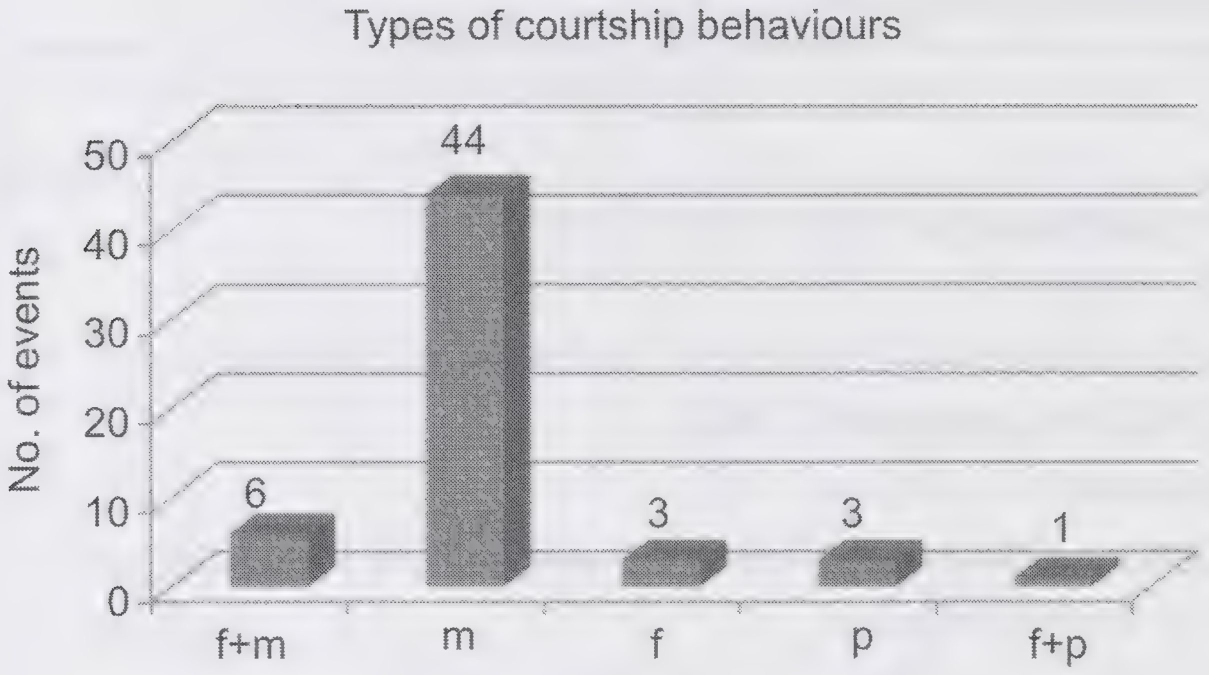

Fig. 1: Types of courtship behaviours observed
(n = 57 events, events of mounting = 50)
*Abbreviations: f+m= feeding+mounting; m= only mounting; f= only feeding; p= only preening; f+p= feeding+preening

mating and mating) period. The owlets were monitored using 'focal animal/subgroups sampling' method (Altmann 1974) and the observed behaviours were noted, photo-documented and classified based on functions. The birds were observed for an hour daily between 18:30–21:30 hrs with the help of torches and binoculars. A total of 303 hrs were spent observing the two adult and two juvenile owlets (of unknown sex). For quantification of courtship behaviours, the number of mountings, and behaviours by either owlet before and after mounting were noted. A literature survey was done to assimilate the recorded behaviour patterns, to construct an ethogram for the species.

RESULTS

A total of 34 individual behaviours were identified for the adults, which were classified into 10 functional groups (Table 1). The juvenile owlet behaviours were of four types classified in four functional groups (Table 2). Some of the behaviours are explained using images (Figs 3–6). The maximum number of individual behaviours was recorded for the functional group Comfort and Maintenance (11), followed by Vocalization (4).

Of the 50 mounting events recorded, the male (presumed male from position during copulation) brought food [insects (n=2), centipedes (n=1) and geckos (n=3)] to the

Table 1: Ethogram for adult Spotted Owlet

Sr. No	Functional group	Individual behaviour (34)	Description	References
1	Alert	Staring and bobbing or bowing	Up and down movements of head and/or with staring with eyes wide open. Performed when threatened or curious. Four stages of bowing are described by previous studies.	Kumar (1985), Ali (2002), Mahmood ul Hassan (2008), Jose (1964), Nilakanta (1972), Present study
		Back turning	Head turns around almost by 180 degrees to face the intruder.	Kumar (1985), Nilakanta (1972), Present study
2	Resting	Huddling	Two or more owlets sitting very close together with eyes partially closed on a branch during the day or just before dark.	Ali (2002), Present study
		Sleeping	Eyes completely/partially closed while perching.	Kumar (1985), Present study
3	Comfort and maintenance	Scratching	The head/neck regions are rubbed with the toe.	Kumar (1985), Present study
		Preening	Feathers are groomed using the beak. It might be self-preening or allopreening. Generally observed in the evening.	Kumar (1985), Mahmood ul Hassan (2008), Present study
		Wing and leg stretching	Performed just after emerging from roost/nest.	Mahmood ul Hassan (2008), Present study
		Wing fluttering/wing fan	Wings extended and flapped while remaining perched.	Kumar (1985), Mahmood ul Hassan (2008), Present study
		Bill gaping	Mouth is kept open for a short while and head held high.	Kumar (1985), Present study
		Toe/leg cleaning	One toe is cleaned with the help of the beak generally after feeding.	Kumar (1985), Present study
		Body fluffing	Feathers on the body are erected for a short time and then followed by a 'body shake'. Also includes 'sleeked plumage' described by previous studies.	Kumar (1985), Present study

Table 1: Ethogram for adult Spotted Owlet (*contd.*)

Sr. No	Functional group	Individual behaviour (34)	Description	References
		Gular fluttering	Observed during the hot days. Bill opened, head raised and followed by fluttering	Kumar (1985)
		Tail and wing flick	Downward motion of the tail followed by lateral motion and later by upward motion. Wing flick consisted of rapid extension of both the wings forward	Kumar (1985), Present study
		Bill wiping	After feeding, the owlet rubs its beak sideways on a branch with eyes closed for removing any food attached.	Kumar (1985), Present study
		Peck down	Single/multiple pecking movements resembling normal feeding	Kumar (1985)
4	Locomotion	Walking	The bird walks with an awkward gait on the ground during feeding of terrestrial prey.	Present study
		Flying	The flight from one perch to another is short, swift and with fast wing beats.	Present study
		Hovering	One of the methods used to catch prey.	Allen (1920), Nilakanta (1972)
5	Ingestion and Excretion	Foraging and feeding	Having perched on a branch, the owlet scans the ground for prey. On spotting, it grasps the prey swiftly using its talons or beak. After catching, the prey is held in one toe and eaten part by part (lizards, frogs) or ingested whole (smaller insects). Eyes are closed sometimes while ingestion. Wings could also be extended slightly. During the breeding season, the female hunts small sized prey and feeds it to the young while holding it in her beak.	Mahmood ul Hassan (2008), Present study
		Defecation	Performed randomly during the study period while perched. Faecal matter is excreted.	Present study
		Pellet regurgitation	Undigested prey parts are ejected out from the mouth in the form of an elongated mass.	Kumar (1985), Jadhav and Parasharya (2003), Present study
6	Inter-specific response	Looking skyward	Tilted head pointing upwards, generally when another raptor is around.	Present study
		Response to aggressive behaviour	As a result of attacking by the Common Myna, owlets reported to vacate nests.	Prakash (1963)
		Male territorial behaviour	During the breeding season, two males interacted/ threatened each other through vocalizations	Present study
7	Researcher induced behaviour	Attacking	Aggressive response of the owlets by swooping down from the roost and attacking humans	Gupta (1966)
		Distraction display	Flying over intruders, fast movements, zig-zag wing beats, loud screeches with widely opened bill	Kumar (1985)
8	Sexual behaviour	Male courtship behaviour	Before copulation, the male offers prey to the female – ritual feeding. This is followed by preening. Reported in the Forest Owlet (Ishtiaq and Rahmani 2005; Jathar and Rahmani 2004; Jathar and Rahmani 2011)	Present study
		Female courtship behaviour	Female perches on a branch and utters begging calls (*churr...churr*). Reported in Forest Owlet (Jathar and Rahmani 2011)	Mahmood ul Hassan (2008), Present study
		Copulation behaviour	a) Mounting: The male mounts the female from the top. The female leans forward, partially extends the wings laterally and deflects tail. Reported in the Forest Owlet (Jathar and Rahmani 2011)	Mahmood ul Hassan (2008), Present study

Table 1: Ethogram for adult Spotted Owlet (*contd.*)

Sr. No	Functional group	Individual behaviour (34)	Description	References
			b) Post mounting preening: After mounting, the male preens the female. Reported in the Forest Owlet (Jathar and Rahmani 2011).	Kumar (1985), Present study
			c) Post copulation feather shake: After copulation, both the partners shake feathers briefly.	Present study
9	Maternal behaviour	Incubation	Adult of unknown sex seen incubating the eggs.	Jadhav and Parasharya (2003)
10	Vocalizations	Chuckling call	Harsh, chattering, squabbling and chuckling notes with irregular bursts of jarring, raucous, scolding crackles. This call as reported as *chirurrr- chirurrr...cheevak- cheevak* and termed as 'screeching' by previous studies.	Ali (2002), Rasmussen and Anderton (2005), Kumar (1985), Brahmachary *et al.* (1972) Nilakanta (1972), Present study
		Begging calls	These calls were uttered multiple times before and after mating by the female.	Mahmood ul Hassan (2008), Present study
		Sharp note call uttered by male	A short, monosyllabic *peeew/ keeew* was uttered by the male. After the male's call, on all the five occasions, the female immediately replied with begging calls. The male usually uttered this call just before the ritual feeding.	Probably the 'contact call' as described by Rasmussen and Anderton (2005), Present study
		Calling during mounting	This vocalization was heard during each mounting event of more than 4 seconds. When the male starts to mount the female utters short, multiple successive *kho- kho- kho* calls, followed by a squeaky note just before the male leaves the female. This call was heard on 24 occasions. (See Fig. 2)	Present study

female during 6 (12%) mating/mounting events. The number of events of ritual feeding by the male that was not followed by mounting, events of allopreening followed by feeding, and events of only preening are represented in Fig. 1. The ratio of mountings to ritual feeding followed by mounting events was 44:06, indicating a comparatively low frequency of ritual feeding after mounting in the Spotted Owlet.

DISCUSSION

Walter (1983) highlighted homogeneity in the behaviour of Strigidae members. Our observations pertaining to the sequence of behaviours during mounting/mating is partially in line with those of Mahmood ul Hassan (2008), but with a few exceptions. Ritual feeding behaviour by the male during courtship was not reported earlier, but was observed in the diurnal Forest Owlet (Jathar and Rahmani 2004). During mounting, a characteristic call was heard (Fig. 2) that was not reported earlier (Mahmood ul Hassan 2008).

In order to study behaviour, it is necessary to list all the discrete responses to stimuli shown by the animal (Sakamoto *et al.* 2009). Thus, description and classification of behaviour or formulating an ethogram of the species is a prerequisite for further quantitative studies (MacNulty *et al.* 2007). Ethogram data for several related species (say owls) can be further collated and an 'Actigram' (Walter 1983) should be drafted for the taxa to ensure uniformity, objectivity which would render behavioural data comparable. Such

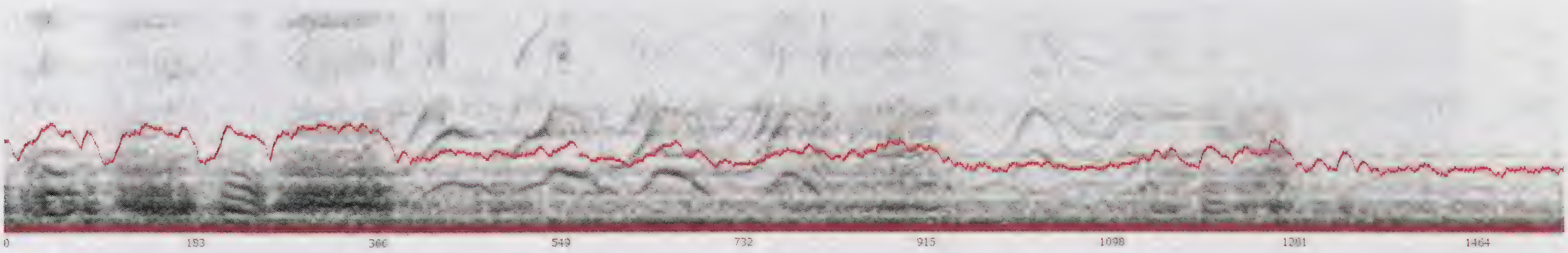

Fig. 2: Analysis of the call during mounting

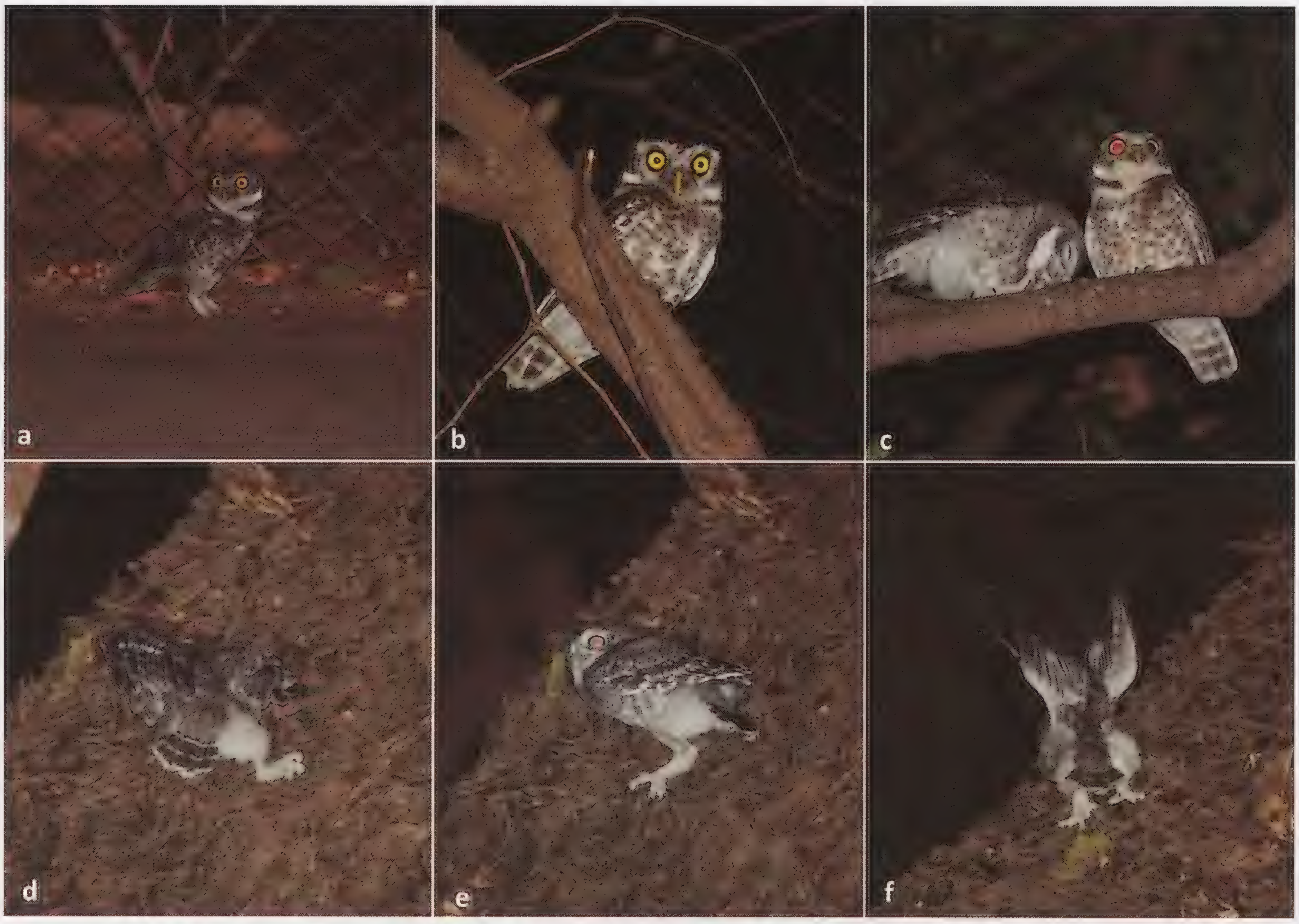

Fig. 3: (a) Walking on ground; (b) Staring; (c) Feeding by the adult (on right) to the juvenile (on left); (d-f) Flying practice by juveniles

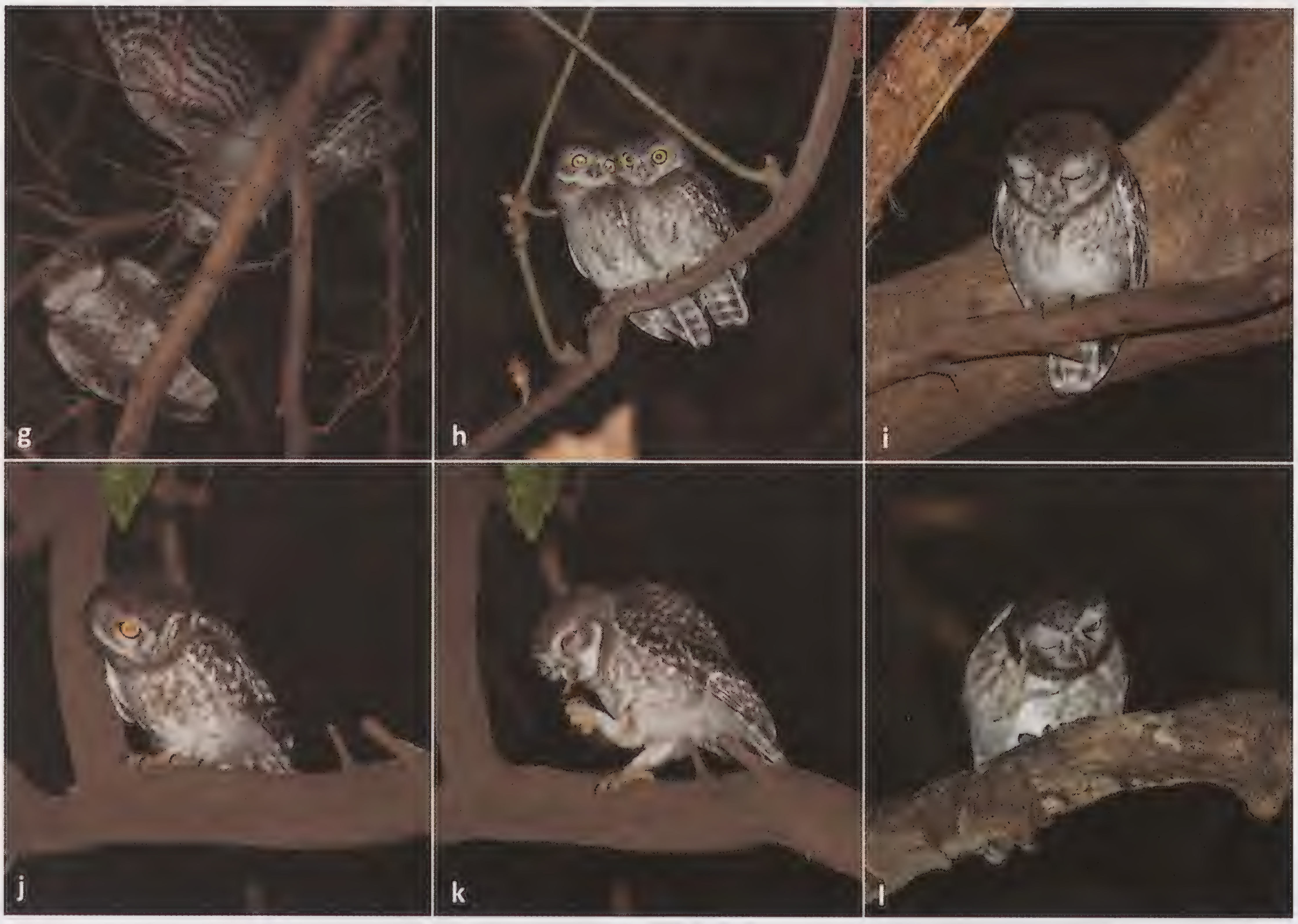

Fig. 4: (g) Prey in beak of the juvenile (on right) delivered by adult; (h) Resting behaviour of juveniles; (i) Toe cleaning behaviour; (j) Scanning for prey; (k) Feeding behaviour - prey item in one leg; (l) Scratching

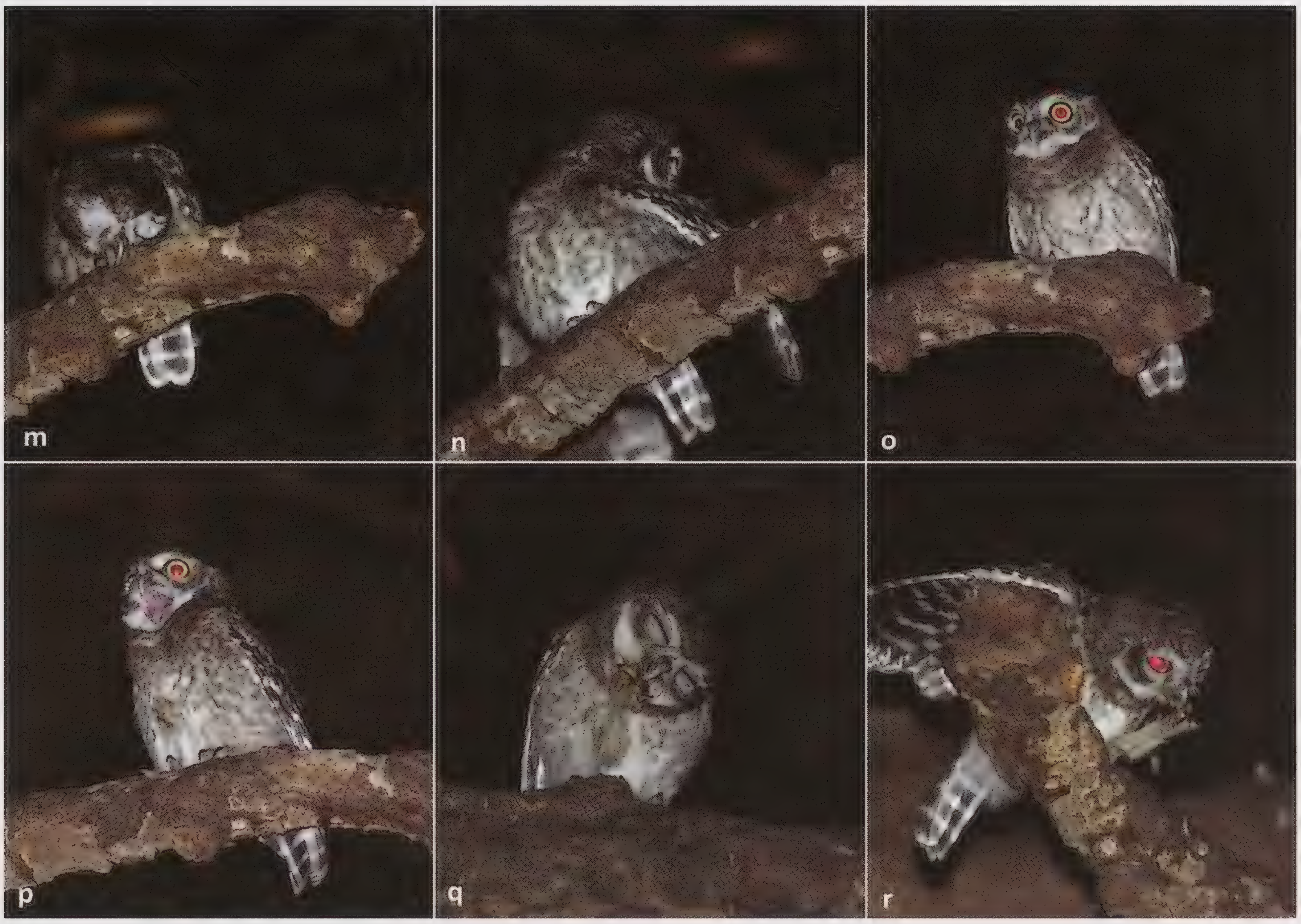

Fig. 5: (m) Bill wiping after feeding; (n) Self preening; (o) Juvenile waiting for prey delivery by the adult; (p) Bill gaping; (q) Eyes closed while feeding; (r) Eyes open and wings extended during feeding

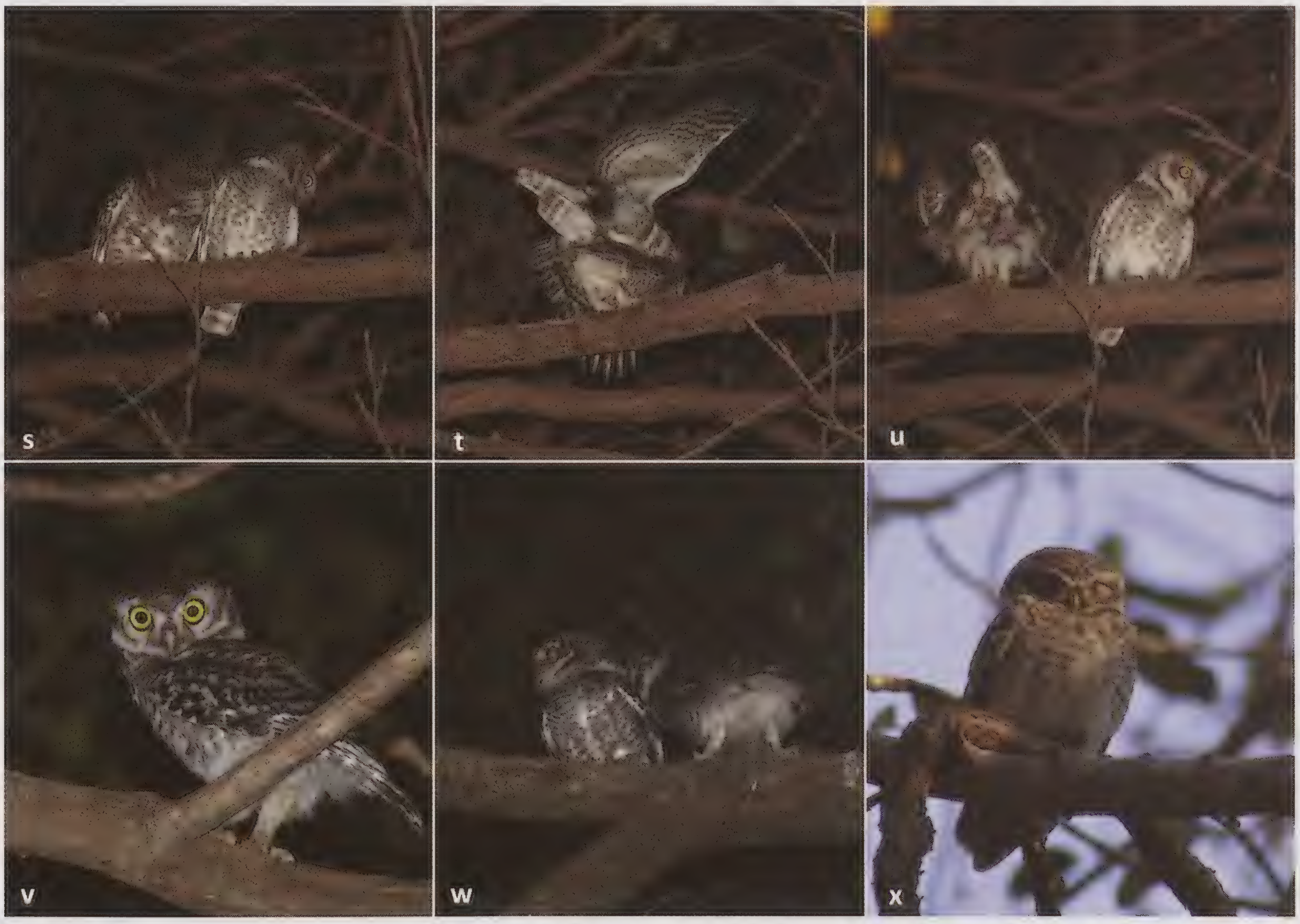

Fig. 6: (s) Allopreening just before mounting; (t) Mounting. Male on the top and female below; (u) Self preening by the female near cloacal region just after mating; (v) Back turning; (w) Adult preening a juvenile; (x) Resting during daylight with eyes closed

Table 2: Ethogram for Juvenile Spotted Owlet

Sr. No	Functional group	Individual behaviours	Description	References
1	Alert	Threat display	Wing extension, ruffling, bill opening, hissing/screeching and bill snapping	Kumar (1985)
2	Comfort and Maintenance	Preening	One of the adults preens the juvenile	Kumar (1985), Present study
3	Locomotion	Flying practice	The attempts of juvenile to fly	Present study
4	Vocalization	Begging calls	Uttered by juveniles between two feeding sessions. These calls are described as low, hissing, shrill *vshhh-vshhh*	Kumar (1985), Present study

baseline studies on the ethology of this species will be useful in calculating the time-activity budgets for this species.

The current work on the construction of an ethogram for the Spotted Owlet provides standard definitions of the multiple behaviours. Due to logistical limitations, we could not document the behaviours exhibited during nesting like incubation, egg turning etc. Also, daytime behaviours were not observed in detail. Further, age, sex and habitat specific studies along with correlation with other environmental parameters could provide better insights into the ethology of the species.

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TAXONOMIC STUDIES ON THE GRASSHOPPER FAUNA (ORTHOPTERA: ACRIDIDAE) RECORDED FROM PADDY FIELDS IN UTTAR PRADESH, INDIA

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India has the world's largest area under rice cultivation and Uttar Pradesh is one of the chief rice producing states. During surveys of paddy fields in Uttar Pradesh, 21 species of grasshoppers representing 14 genera of Family Acrididae, belonging to 7 subfamilies, were recorded in 2010, 2011, and 2012. A maximum number of seven species represented the subfamily Oedipodinae, followed by Oxyinae with five species and one subspecies, Acridinae with three species, Hemiacridinae and Catantopinae with two species each, and Spathosterninae and Eyprepocnemidinae with one species each.

Key words: Taxonomy, Grasshopper, Acrididae, paddy fields, Uttar Pradesh

INTRODUCTION

Orthoptera is one of the largest orders of insects and constitutes 22,500 species (Ghosh and Sengupta 1982) worldwide, out of which 1,750 species, 400 genera and 21 families are known from India (Tandon and Hazra 1998). It currently comprises 26,730 valid species worldwide (Eades *et al.* 2015). The Order Orthoptera is divided into two suborders, i.e., Caelifera or short-horned grasshoppers and Ensifera or long-horned grasshoppers (Ander 1939). Acridoidea, the largest superfamily with 11,000 species worldwide, has 290 species representing 138 genera reported from India (Shishodia *et al.* 2010). Family Acrididae shows the maximum diversity, comprising 8,000 species, of which 136 species under 28 genera are endemic (Chandra and Gupta 2013).

Acridids cause considerable damage to agricultural crops, pastures and forests, and are well-reputed for their destructiveness all over the world (Joshi *et al.* 1999). They are primarily graminivorous, feeding on several common grasses and sedges (Mulkern 1967).

The major work on Indian Orthoptera was published by Kirby (1914) in FAUNA OF BRITISH INDIA, wherein 329 species belonging to 124 genera and 8 subfamilies, under family Acrididae were reported. Grasshoppers of India were published by Tandon (1976) and Shishodia *et al.* (2010), and of different states of India such as Kerala by Priya and Narendran (2003), Madhya Pradesh, Himachal Pradesh by Shishodia and Gupta (2009), northeast India by Usmani and Khan (2010), Jharkhand by Nayeem and Usmani (2012), Punjab by Kumar and Usmani (2012) and Bihar by Nayeem *et al.* (2013) respectively.

There are sporadic reports on the grasshopper fauna of Uttar Pradesh, but no consolidated report on taxonomic studies on grasshoppers of paddy, and the present study is the first effort. From western Uttar Pradesh, 33 species of locusts and grasshoppers were reported by Usmani *et al.* (2010); 14 species from pulses of Uttar Pradesh by Usmani *et al.* (2012a). 32 species of grasshoppers were reported from Aligarh by Usmani *et al.* (2012b). Biology of *Acrida gigantea* and *Spathosternum prasiniferum* has been studied by Usmani *et al.* (2012c) and Usmani and Rafi (2013), while grasshoppers of Purvanchal region of Uttar Pradesh have been studied by Rafi and Usmani (2013).

Uvarov (1922) first studied the grasshoppers of paddy in the Old World. Akhtar *et al.* (2012) explored the grasshopper pests of paddy from Uttar Pradesh; Usmani *et al.* (2012d) reported grasshoppers of pulses and paddy from Bihar and Jharkhand. Chitra *et al.* (2000) reported 28 species of grasshoppers from paddy of Coimbatore, while Chitra *et al.* (2001) described the grasshopper pests of rice in southern India. Kandibane *et al.* (2004) studied grasshoppers from irrigated rice ecosystems in Madurai, Tamil Nadu respectively.

Hieroglyphus banian has been reported as a pest of paddy from Maharashtra by Jadhao and Khurad (2011), and also from north-eastern Uttar Pradesh by Singh and Singh (2014). This species was also reported by Das *et al.* (2002) from paddy fields in West Bengal. Bhatia *et al.* (1965) recorded *Hieroglyphus nigrorepletus* from the desert part of Rajasthan, and Singh (1972) from Kutch district of Gujarat. *Acrida exaltata* was confirmed as pest of paddy in India by Haldar *et al.* (1995), and confirmed by Khan *et al.* (1963) from Rajasthan. Riffat and Wagan (2007, 2008) confirmed *Hieroglyphus nigrorepletus* as a pest of paddy in Pakistan.

Asian rice *Oryza sativa* (family Poaceae) is one of the most important staple foods of the world, especially in Asia. It is a plant of wet and humid climate and is cultivated twice a year in most parts of India, the crops are known as Rabi and Kharif.

MATERIAL AND METHODS

I. **Study area**: Uttar Pradesh (northern India) is the top-ranking state in the country in terms of population – more than 199.5 million people as per the census 2011. The state is bordered by Rajasthan to the west, Haryana and Delhi to the northwest, Uttarakhand to the north, Bihar to the east, Jharkhand to the southeast and Madhya Pradesh to the southwest. It is located at 26.85° N, 80.91° E and spread across a land area of 2,43,286 sq. km. The State is demarcated into three distinct regions, the Himalayan region in the north, the Gangetic plains in the centre and the Vindhya hills and plateau to the south. It is characterized by highly fertile alluvial soil and the River Ganga. Being in the fertile Gangetic plains, it is an agricultural haven and the largest food producer of India. The crops cultivated are rice, wheat, barley, and sugarcane. The Vindhya hills and the plateau in the south comprise hard rock strata with a varied topography of hills, valleys, plateaux, and plains.

It has a humid temperate climate and experiences four seasons. The winter in January and February is followed by summer between March and June and the monsoon season between June and September. Summers are extreme with temperatures fluctuating anywhere between 0 °C and 50 °C in parts of the state. The Gangetic plain varies from semiarid to sub-humid. The mean annual rainfall ranges from 650 mm in the southwest corner of the state to 1,000 mm in the eastern and southeastern parts of the state. The climate of the Vindhya Range and plateau is subtropical with a mean annual rainfall between 1,000 and 1,200 mm, most of which comes during the monsoon. Typical summer months are from March to June, with maximum temperatures ranging from 30 to 38 °C.

II. **Collection and preservation**: Grasshoppers were collected by hand and by sweeping using a aerial insect net; the net was used for catching insects individually or by sweeping over crops. The insects caught were transferred to a bottle that containing cotton soaked in ethyl acetate, to kill the specimen. Once killed, the specimen was removed from the bottle to prevent morphological changes, specifically colour change.

III. **Identification**: Specimens were first relaxed (right wings were stretched putting a piece of paper on it, and pinned by inserting a pin on the posterior right on thorax) on a stretching board and left to dry for 72 hours. The specimens were later identified up to species level on the basis of external morphological characters with the help of stereoscopic microscope and keys in available literature.

IV. **Morphometry**: This was done (in mm) with the help of Vernier callipers. Mean and Standard Deviation were calculated to show the possible mean deviation of body size and to determine the stability of the data.

V. **Storage**: Pinned specimens were kept in storage boxes and cabinets, with naphthalene balls to prevent decomposition. Wet specimens were stored in 70% ethyl alcohol in plastic vials.

RESULTS

A total of 21 species of grasshoppers representing 14 genera of Family Acrididae belonging to seven subfamilies have been recorded during survey from paddy fields of Uttar Pradesh during three years 2010, 2011, and 2012. Maximum seven species from subfamily Oedipodinae (*Oedaleus abruptus*, *O. senegalensis*, *Aiolopus simulatrix simulatrix*, *A. thalassinus thalassinus*, *Heteropternis respondens*, *Trilophidia annulata*, and *Acrotylus humbertianus*), followed by Oxyinae with five species (*Gesonula punctifrons*, *Oxya fuscovittata*, *Oxya hyla*, *Oxya japonica japonica* and *Oxya velox*), Acridinae with three species (*Truxalis nasuta, Acrida exaltata* and *Acrida gigantea*), Hemiacridinae with two species (*Hieroglyphus banian* and *Hieroglyphus nigrorepletus*), Catantopinae with two species (*Xenocatantops karnyi* and *Diabolocatantops pinguis*), Spathosterninae (*Spathosternum prasiniferum prasiniferum*) and Eyprepocnemidinae (*Eyprepocnemis alacris*) with one species each.

This conforms with the result of Akhtar *et al.* (2012) who recorded 26 species of Acridoidea from rice ecosystem of Uttar Pradesh; Chitra *et al.* (2000) who reported 28 species of grasshoppers from rice field of Coimbatore. Jadhao and Khurad (2011) described only one species of grasshopper *Hieroglyphus banian* out of 23 species of insect pest of rice ecosystem from Maharashtra. Singh and Singh (2014) reported *Hieroglyphus banian* as a pest of rice from north-eastern Uttar Pradesh, whereas Akhtar *et al.* (2014b) described *Hieroglyphus nigrorepletus* as a major pest of paddy and reported taxonomic studies of *H. banian* and *H. nigrorepletus* in Uttar Pradesh (Akhtar *et al.* (2014a). This result is on par with the findings of Kandibane *et al.* (2004) with only fifteen species of grasshoppers described from irrigated fields of rice ecosystem and Paulraj *et al.* (2009) reported only four species of grasshoppers.

KEY TO SUBFAMILIES OF INDIAN ACRIDIDAE MACLEAY, 1821

1. Prosternal process usually absent, if present, body strongly elongate and antennae ensiform; hind tibia without external apical spine 2
— Prosternal process present; hind tibia with or without external apical spine; tubular 3
2. Body usually slender; frons oblique; medial area of tegmen usually without intercalary vein, if present, never serrated in both sexes .... Acridinae Macleay, 1802
— Body rather sturdy; frons usually vertical; medial area of tegmen with intercalary vein usually serrated .... Oedipodinae Walker, 1871
3. Lower knee lobe of hind femur never spined; valves of ovipositor never serrate or spined; hind tibia never flattened 4
— Lower knee lobe of hind femur spined; valves of ovipositor serrate or spined; hind tibia flattened .... Oxyinae Brunner, 1893
4. Radial area of tegmen with transverse stridulatory veinlets 5
— Radial area of tegmen without transverse stridulatory veinlets 6
5. Radial area of tegmina with some parallel, thickened, transverse stridulatory veinlets; prosternal process not spatulate .... Hemiacridinae Dirsh, 1956
— Radial area of tegmina with a series of regular, parallel, condensed transverse stridulatory veinlets; prosternal process spatulate .... Spathosterninae Rehn, 1957
6. Pronotum with lateral carinae linear; male cercus strongly compressed, apex downcurved .... Eyprepocnemidinae Brunner, 1893
— Pronotum without lateral carinae, if present, never linear; male cercus variable, never strongly compressed, apex normal .... Catantopinae Brunner, 1893

KEY TO INDIAN GENERA OF SUBFAMILY ACRIDINAE MACLEAY, 1821

1. Stridulatory file present on inner side of hind femur .. .. *Truxalis* (Fabricius, 1775)
— Stridulatory file absent .... *Acrida* (Linnaeus, 1758)

- *Truxalis* is represented by single species, i.e. *Truxalis nasuta*

Key to Indian species of *Acrida* Linnaeus, 1758

1. Lateral carinae not edged within a black line .... *Acrida exaltata* (Walker, 1859)
— Lateral carinae edged within a black line .... *A. gigantea* (Herbst, 1786)

KEY TO INDIAN GENERA OF SUBFAMILY OEDIPODINAE WALKER, 1871

1. Dorsum of pronotum with X-shaped pattern .... *Oedaleus* Fieber, 1853
— Dorsum of pronotum without X-shaped pattern 2
2. Pronotum with median carina crossed by one transverse sulcus or not crossed at all 3
— Pronotum with median carina intersected by two or more transverse sulci 4
3. Pronotum with median carina weak .... *Aiolopus* Fieber, 1853
— Pronotum with median carina well-developed .... *Heteropternis* Stal, 1873
4. Pronotum with median carina strongly raised in prozona forming two tooth-like projections, sharp in metazona .... *Trilophidia* Stal, 1873
— Pronotum with median carina equally raised in prozona and metazona, not forming tooth-like projection .... *Acrotylus* Fieber, 1853

Key to Indian species of *Oedaleus* Fieber, 1853

1. Hind wings fascia complete; posterior transverse sulcus placed in the middle .... *Oedaleus senegalensis* (Krauss, 1877)
— Hind wings fascia broadly interrupted; posterior transverse sulcus placed much before the middle .... *O. abruptus* (Thunberg, 1815)

Key to Indian species of *Aiolopus* Fieber, 1853

1. Hind femora short and stout, as wide as width of tegmina; pronotum weakly narrowed and moderately constricted in prozona ....*Aiolopus simulatrix simulatrix* (Walker, 1870)
— Hind femora long and slender, narrower than width of tegmina; pronotum saddle-shaped, distinctly narrowed and constricted in prozona .... *A. thalassinus* (Fabricius, 1781)

- *Heteropternis* is represented by single species i.e., *Heteropternis respondens respondens*
- *Trilophidia* is represented by single species i.e., *Trilophidia annulata*
- *Acrotylus* is represented by single species i.e., *Acrotylus humbertianus*

KEY TO INDIAN GENERA OF SUBFAMILY OXYINAE BRUNNER, 1893

1. Antennae longer than head and pronotum together; radial area of tegmina with a series of transverse stridulatory veinlets; female ovipositor valves short with acute dents, apical tips pointed; male supra-anal plate with spatulate apex; cercus long and conical .... *Gosonula* Uvarov, 1940

— Antennae longer than, as long as, or shorter than head and pronotum together; radial area of tegmina lacking stridulatory veinlets; female ovipositor valves long and slender, serrated, toothed or spined; male supra-anal plate with rounded or angular apex; cercus simple or compressed .... *Oxya* Serville, 1831

- *Gosonula* is represented by single species i.e., *Gosonula punctifrons*

Key to Indian species of *Oxya* Fieber, 1853

1. Posterior ventral basivalvular sclerites of ovipositor without any well-defined spines on its ventral inner margin... 2

— Posterior ventral basivalvular sclerites of ovipositor with one or two tooth-like spines on its ventral inner margin.. 3

2. Male cercus with bifid apex ....*Oxya fuscovittata* (Marschall, 1836)

— Male cercus conical with subacute apex .... *O. velox* (Fabricius), 1787

3. Ovipositor valves with long hook-like dents; posterior ventral basivalvular sclerites with small spinelets on its inner ventral margin; male cercus with subacute or truncate apex .... *O. hyla* Serville, 1831

— Ovipositor valves with short dents; posterior ventral basivalvular sclerites with a large spine on its inner ventral margin; male cercus with bifid apex .... *O. japonica japonica* (Thunberg), 1815

Key to subspecies of *Oxya hyla* Serville, 1831

1. Ventral surface of subgenital plate with two longitudinal ridges extending forwards from posterior margin, these ridges often spined; epiphallus with inner lophi usual ....*Oxya hyla hyla* Serville, 1831

— Ventral surface of subgenital plate without longitudinal ridges or with only slight traces of them apically and they are not at all spined; epiphallus with inner lophi reduced or absent ....*O. hyla intricata* (Stal, 1861)

KEY TO INDIAN GENERA OF SUBFAMILY HEMIACRIDINAE DIRSH, 1956 AND SPATHOSTERNINAE REHN, 1957

1. Prosternal process conical, never compressed, elytra or wings fully developed or shortened, dorsum of pronotum rounded or flattened, lateral carinae present or absent ....*Hieroglyphus* Krauss, 1877

— Prosternal process anteroposteriorly compressed; elytra or wings fully developed, much longer than pronotum; dorsum of pronotum flattened, lateral carina present. .... *Spathosternum* Krauss, 1877

Key to Indian species *Hieroglyphus* Krauss, 1877

1. Dorsum of pronotum with two broad black parallel bands connecting all sulci ....*Hieroglyphus nigrorepletus* Bolivar, 1912

— Dorsum of pronotum without bands connecting all sulci ....*H. banian* (Fabricius, 1798)

- *Spathosternum* is represented by single species i.e., *Spathosternum prasiniferum prasiniferum*

KEY TO THE GENERA OF THE SUBFAMILY CATANTOPINAE BRUNNER, 1893

1. Pronotum slightly constricted in prozona; prosternal process acutely conical.. ....*Xenocatantops* Dirsh & Uvarov, 1953

— Pronotum not constricted in prozona; prosternal process cylindrical, anteroposteriorly compressed................. .... *Diabolocatantops* Jago, 1984

- *Xenocatantops* is represented by single species i.e., *Xenocatantops karnyi*
- *Diabolocatantops* is represented by single species i.e., *Diabolocatantops pinguis*

* SUBFAMILY EYPREPOCNEMIDINAE

This subfamily is represented by a single genus and species i.e., *Eyprepocnemis alacris*

TAXONOMIC ACCOUNT

Truxalis nasuta (Linnaeus, 1758)

Gryllus (*Acrida*) *nasutus* Linnaeus, 1758. *Systema Naturae per Regna tria naturae*, (10th ed.) 1: 427.

Truxalis nasuta (Linnaeus); Massa, 2009. *Jour. Orth. Res.* 18(1): 87.

Diagnostic characters: Head elongate, acutely conical; fastigium of vertex elongate; fastigial foveolae absent; frons oblique; frontal ridge shallowly sulcate; pronotum elongate, slightly tectiform and saddle-shaped with well-developed median carina and dorsum crossed by posterior sulcus only, lateral carinae straight or slightly excurved; metazona as long as or slightly shorter or slightly longer than prozona, posterior margin angular.

Distribution: INDIA: Chattisgarh, Jammu & Kashmir, Uttar Pradesh, Punjab, and Rajasthan. ELSEWHERE: Myanmar and Sri Lanka.

Material Examined: Azamgarh, 4♂, 6♀, 08.x.2010; Fatehpur, 5♂, 4♀, 10.ix.2011; Etawah, 3♂, 4♀, 08.viii.2012; Aligarh, 5♂, 4♀, 01.viii.2012; Saharanpur, 3♂, 5♀, 23.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	37.89–42.58	38.94–43.37	39.65 ± 1.60	41.38 ± 1.49
Pronotum	7.21–8.32	7.72–8.82	7.76 ± 0.42	8.28 ± 0.40
Tegmina	28.48–30.24	28.67–30.25	29.12 ± 0.60	29.32 ± 0.56
Hind Femur	17.66–19.36	18.67–19.78	18.33 ± 0.58	19.08 ± 0.37

Acrida exaltata (Walker, 1859)

Truxalis exaltata Walker, 1859. *Ann. Nat. Hist.* (3)4: 222.

Acrida exaltata (Walker); Nayeem and Usmani, 2012. *Munis Entomology & Zoology* 7(1): 404.

Diagnostic characters: Head conically ascending, fastigium of vertex wide; pronotum with lateral carinae prominent, not lined internally with black, prozona shorter than metazoan.

Distribution: INDIA: Andaman & Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Odisha (earlier Orissa), Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh, and West Bengal. ELSEWHERE: Afghanistan, Bangladesh, Iran, Pakistan, Saudi Arabia, South East Tibet, Sri Lanka, Yemen, and West Aden.

Material Examined: Varanasi, 2♂, 2♀, 04.x.2010; Azamgarh, 4♂, 5♀, 08.x.2010; Ghazipur, 4♂, 3♀, 09.x.2010; Mau, 4♂, 5♀, 10.x.2010; Ballia, 5♂, 4♀, 11.x.2010; Deoria, 5♂, 6♀, 12.x.2010; Hamirpur, 5♂, 6♀, 04.ix.2011; Jalaun, 4♂, 3♀, 05.ix.2011; Kanpur Dehat, 4♂, 5♀, 06.ix.2011; Fatehpur, 5♂, 4♀, 11.ix.2011; Banda, 5♂, 8♀, 12.ix.2011; Shahjahanpur, 4♂, 3♀, 14.viii.2012; Rampur, 4♂, 3♀, 15.viii.2012; Moradabad, 4♂, 5♀, 16.viii.2012; Muzaffarnagar, 4♂, 4♀, 22.viii.2012; Saharanpur, 5♂, 4♀, 23.viii.2012; Baghpat, 4♂, 5♀, 24.viii.2012; Bijnor, 4♂, 5♀, 25.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	42.46–48.78	62.65–66.72	45.69 ± 3.16	64.63 ± 2.03
Pronotum	6.12–7.38	9.35–10.78	6.78 ± 0.63	10.23 ± 0.77
Tegmina	32.64–37.45	44.65–48.34	34.88 ± 2.42	46.49 ± 1.84
Hind Femur	24.84–30.43	34.68–37.32	27.55 ± 2.79	36.15 ± 1.34

Acrida gigantea (Herbst, 1786)

Truxalis giganteus Herbst, 1786. *Herausgegeben von Johan Caspar Fuessly.* 7-8: 191.

Acrida gigantea (Herbst); Nayeem and Usmani, 2012. *Munis Entomology & Zoology* 7(1): 404.

Diagnostic characters: Pronotum finely granulated, median carina sharp crossed by posterior transverse sulcus only, lateral carinae prominent and edged with a black line.

Distribution: INDIA: Assam, Bihar, Himachal Pradesh, Haryana, Jharkhand, Madhya Pradesh, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarakhand, and West Bengal. ELSEWHERE: Africa and Nepal.

Material Examined: Allahabad, 4♂, 5♀, 06.x.2010; Jaunpur, 5♂, 4♀, 07.x.2010; Azamgarh, 3♂, 4♀, 08.x.2010; Ghazipur, 2♂, 3♀, 09.x.2010; Unnao, 2♂, 3♀, 08.ix.2011; Kannauj, 5♂, 3♀, 09.ix.2011; Auraiya, 3♂, 4♀, 10.ix.2011: Fatehpur, 5♂, 3♀, 11.ix.2011; Aligarh, 3♂, 4♀, 01.viii.2012; Bulandshahr, 3♂, 2♀, 18.viii.2012; Meerut, 3♂, 4♀, 21.viii.2012; Saharanpur, 4♂, 3♀, 23.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	45.25–52.52	63.28–67.46	48.85 ± 3.63	64.64 ± 1.09
Pronotum	7.46–8.84	9.48–10.83	8.18 ± 0.09	10.18 ± 0.67
Tegmina	35.53–38.34	40.52–44.48	36.23 ± 2.46	42.56 ± 1.95
Hind Femur	24.53–28.46	32.43–34.57	26.49 ± 1.96	33.61 ± 1.18

Oedaleus senegalensis (Krauss, 1877)

Pachytylus senegalensis Krauss. 1877. *Anz. Akad. Wiss. Wien* 14: 144.

Oedaleus senegalensis Krauss, Hemp. 2009. *Jour. Orth. Res.* 18(2): 208.

Diagnostic characters: A characteristic X-mark on the pronotum, which is shorter and broadly rounded posteriorly, principal sulcus placed at the middle.

Distribution: INDIA: Andhra Pradesh, Bihar, Delhi, Jammu & Kashmir, Madhya Pradesh, Punjab, Rajasthan, Tamil Nadu, Uttarakhand, Uttar Pradesh, and West Bengal. ELSEWHERE: Afghanistan, North Africa, and Pakistan.

Material Examined: Azamgarh, 2♂, 2♀, 08.x.2010; Ghazipur, 3♂, 2♀, 09.x.2010; Mau, 2♂, 2♀, 10.x.2010; Faizabad, 4♂, 2♀, 24.x.2010; Fatehpur, 3♂, 1♀, 10.ix.2011; Hamirpur, 4♂, 4♀, 04.ix.2011; Aligarh, 1♂, 1♀, 01.viii.2012; Saharanpur, 3♂, 2♀, 23.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	20.48–24.34	21.36–25.82	22.12 ± 1.99	23.92 ± 2.30
Pronotum	3.88–4.32	4.36–4.86	4.10 ± 0.22	4.56 ± 0.26
Tegmina	18.26–19.46	19.15–20.68	18.80 ± 0.60	20.05 ± 0.79
Hind Femur	10.57–11.78	11.70–12.41	11.26 ± 0.62	12.14 ± 0.38

Oedaleus abruptus (Thunberg, 1815)

Gryllus abruptus Thunberg, 1815. *Mem. Acad. Imp. Sci. St. Peterburg*. 5: 233.

Oedaleus abruptus (Thunberg); Nayeem & Usmani, 2012. *Munis Entomology & Zoology* 7(1): 408.

Diagnostic characters: Body small to medium sized, green to dull brick red with brown and white markings; fastigium of vertex angular, flat or slightly concave, with obtuse lateral carinulae; hind wings fascia broadly interrupted, anterior termination of hind wing fascia flattened, reaching or just surpassing second anal vein.

Distribution: INDIA: Andhra Pradesh, Arunachal Pradesh, Bihar, Chhattisgarh, Delhi, Goa, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Odisha, Pondicherry, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh, and West Bengal. ELSEWHERE: Afghanistan, Bangladesh, China, Indo-China, Myanmar, Nepal, Pakistan, Sri Lanka, Taiwan, Thailand, and Vietnam.

Material Examined: Mirzapur, 2♂, 2♀, 02.x.2010; Azamgarh, 3♂, 3♀, 08.x.2010; Ghazipur, 2♂, 3♀, 09.x.2010; Hamirpur, 2♂, 3♀, 04.ix.2011; Jalaun, 3♂, 4♀, 05.ix.2011; Kanpur Dehat, 2♂, 2♀, 06.ix.2011; Fatehpur, 3♂, 2♀, 11.ix.2011; Aligarh, 3♂, 4♀, 01.viii.2012; Firozabad, 4♂, 1♀, 05.viii.2012; Saharanpur, 4♂, 4♀, 23.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	20.45–22.32	25.28–26.45	21.44 ± 0.94	26.01 ± 0.63
Pronotum	3.14–3.76	4.25–4.86	3.48 ± 0.31	4.48 ± 0.32
Tegmina	15.27–16.14	19.36–20.82	15.73 ± 0.43	20.20 ± 0.75
Hind Femur	10.32–11.65	13.52–14.58	11.06 ± 0.67	14.15 ± 0.55

Aiolopus simulatrix simulatrix (Walker, 1870)

Epacromia simulatrix Walker, 1870. *Catalogue of the Specimens of Dermaptera Saltatoria in the Collection of the British Museum*. 4: 773.

Aiolopus simulatrix simulatrix (Walker); Hollis, 1968. *Bull. Br. Mus.* (*Nat. Hist.*) *Ent*. 22(7): 320.

Diagnostic characters: Head obtusely rounded in profile; fastigium of vertex elongate angular, slightly longer than wide; fastigial foveolae visible from above, slightly depressed, longer than wide; frons slightly oblique; pronotum finely tectiform, constricted in prozona, posterior transverse sulcus crossing median carina, prozona shorter than metazona, median carina sharp, lateral carinae lacking.

Distribution: INDIA: Andaman & Nicobar Islands, Bihar, Delhi, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarakhand, and West Bengal. ELSEWHERE: Africa, Arabian Peninsula, Islands of Indian Ocean, Pakistan, Myanmar, and Seychelles.

Material Examined: Allahabad, 2♂, 2♀, 06.x.2010; Azamgarh, 4♂, 3♀, 08.x.2010; Ghazipur, 3♂, 3♀, 09.x.2010; Mau, 3♂, 2♀, 10.x.2010; Deoria, 2♂, 3♀, 12.x.2010; Gorakhpur, 2♂, 3♀, 14.x.2010; Gonda, 2♂, 3♀, 20.x.2010; Faizabad, 3♂, 2♀, 24.x.2010; Sultanpur, 3♂, 4♀, 25.x.2010; Kanpur Nagar, 3♂, 4♀, 07.ix.2011; Fatehpur, 3♂, 3♀, 11.ix.2011; Aligarh, 2♂, 3♀, 01.viii.2012; Shahjahanpur, 4♂, 3♀, 14.viii.2012; Rampur, 3♂, 3♀, 15.viii.2012; Moradabad, 3♂, 3♀, 16.viii.2012; Saharanpur, 4♂, 3♀, 23.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	16.86–20.98	19.41–23.58	18.80 ± 2.07	21.84 ± 2.16
Pronotum	3.24–3.96	3.69–4.48	3.59 ± 0.36	4.16 ± 0.41
Tegmina	17.46–20.34	17.61–21.10	19.17 ± 1.51	19.03 ± 1.28
Hind Femur	9.15–10.32	10.38–11.66	9.76 ± 0.58	11.13 ± 0.66

Aiolopus thalassinus thalassinus (Fabricius, 1781)

Gryllus thalassinus Fabricius, 1781. *Species Insectorum* 1: 367.

Aiolopus thalassinus thalassinus (Fabricius); Nayeem & Usmani, 2012. *Munis Entomology & Zoology* 7(1): 407.

Diagnostic characters: Median carina sharp, lateral carinae apparent in metazona while obsolete in prozona; fastigium of vertex elongate, slightly longer than wide; frons slightly oblique; fastigial foveolae visible from above, shorter, slightly depressed; frontal ridge flat, wide, weakly depressed at median ocellus, converging anteriorly with lateral carinulae weak.

Distribution: INDIA: Arunachal Pradesh, Bihar, Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Rajasthan, Uttarakhand, and Uttar Pradesh. ELSEWHERE: Ethiopia.

Material Examined: Allahabad, 2♂, 2♀, 06.x.2010; Azamgarh, 2♂, 3♀, 08.x.2010; Ghazipur, 2♂, 2♀, 09.x.2010; Deoria, 2♂, 4♀, 12.x.2010; Gorakhpur, 2♂, 2♀, 14.x.2010; Faizabad, 2♂, 2♀, 24.x.2010; Sultanpur, 2♂, 2♀, 25.x.2010; Kanpur Nagar, 3♂, 3♀, 07.ix.2011; Fatehpur, 5♂, 4♀, 11.ix.2011; Aligarh, 3♂, 4♀, 01.viii.2012; Saharanpur, 3♂, 3♀, 23.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	16.46–17.85	20.76–21.64	17.24 ± 0.71	21.24 ± 0.44
Pronotum	2.86–3.43	4.10–4.76	3.13 ± 0.28	4.47 ± 0.32
Tegmina	14.58–15.64	18.58–19.74	15.15 ± 0.53	19.22 ± 0.58
Hind Femur	10.62–11.74	12.58–13.72	11.23 ± 0.56	13.24 ± 0.59

Heteropternis respondens respondens (Walker, 1859)

Acridium respondens Walker, 1859. *Ann. Mag. nat. Hist.* 3–4: 223.

Heteropternis respondens (Walker); Ingrisch & Garai, 2001. *Esperiana*. 8: 763.

Diagnostic characters: Fastigium of vertex nearly as long as wide, frons straight, slightly excurved; frontal ridge flat, granulose, depressed at median ocellus, interocular space twice than frontal ridge and slightly shorter than longest diameter of eye; pronotum weakly tectiform, strongly granulose; mesosternal interspace wide, lobes rounded, much wider than long.

Distribution: INDIA: Andhra Pradesh, Arunachal Pradesh, Bihar, Himachal Pradesh, Karnataka, Meghalaya, Nagaland, Odisha, Sikkim, Uttar Pradesh, and West Bengal. ELSEWHERE: Asia-Tropical, Java, Malaysia, and Sri Lanka.

Material Examined: Allahabad, 3♂, 3♀, 06.x.2010; Azamgarh, 3♂, 4♀, 08.x.2010; Ghazipur, 2♂, 3♀, 09.x.2010; Deoria, 3♂, 3♀, 12.x.2010; Basti, 4♂, 4♀, 18.x.2010; Faizabad, 4♂, 5♀, 24.x.2010; Sultanpur, 2♂, 3♀, 25.x.2010; Hamirpur, 5♂, 3♀, 04.ix.2011; Kanpur Dehat, 3♂, 4♀, 06.ix.2011; Fatehpur, 3♂, 2♀, 11.ix.2011; Raebareli, 2♂, 3♀, 16.ix.2011; Sitapur, 3♂, 3♀, 17.ix.2011; Farrukhabad, 3♂, 4♀, 06.viii.2012; Mainpuri, 3♂, 4♀, 07.viii.2012; Shahjahanpur, 3♂, 4♀, 14.viii.2012; Meerut, 2♂, 3♀, 21.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	16.24–24.32	20.95–26.75	20.03 ± 2.72	23.90 ± 2.13
Pronotum	3.92–5.24	4.24–5.96	4.73 ± 0.44	5.14 ± 0.57
Tegmina	18.41–24.71	22.4–25.37	20.71 ± 2.24	23.93 ± 1.13
Hind Femur	10.73–13.68	11.28–14.02	11.97 ± 1.01	12.72 ± 1.00

Trilophidia annulata (Thunberg, 1815)

Gryllus annulatus Thunberg, 1815. *Mem. Acad. Imp. Sci. St. Peterburg*. 5: 234.

Trilophidia annulata (Thunberg); Nayeem & Usmani. 2012. *Munis Entomology & Zoology* 7(1): 406.

Diagnostic characters: Small sized insect; pronotum rugose with a high median carina forming teeth-like projections in prozona; dorsum crossed by two transverse sulci, prozona considerably shorter than metazona, hind wings yellow at base and brown-black beyond.

Distribution: INDIA: Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Himachal Pradesh, Jammu & Kashmir, Karnataka, and West Bengal. ELSEWHERE: Afghanistan, Bangladesh, Borneo, China, and Vietnam.

Material Examined: Sultanpur, 2♂, 2♀, 25.x.2010; Hamirpur, 4♂, 4♀, 04.ix.2011; Jalaun, 4♂, 4♀, 05.ix.2011; Kanpur Dehat, 3♂, 3♀, 06.ix.2011; Kanpur Nagar, 3♂, 3♀, 07.ix.2011; Unnao, 3♂, 4♀, 08.ix.2011; Ghaziabad, 4♂, 4♀, 17.viii.2012; Bulandshahr, 4♂, 5♀, 18.viii.2012; Meerut, 4♂, 4♀, 21.viii.2012; Muzaffarnagar, 3♂, 3♀, 22.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	13.71–17.06	16.78–19.68	15.41 ± 1.67	18.31 ± 1.45
Pronotum	3.38–3.82	4.32–4.88	3.58 ± 0.22	4.58 ± 0.28
Tegmina	16.76–17.88	18.42–19.26	17.32 ± 0.56	18.84 ± 0.42
Hind Femur	8.25–8.86	9.33–9.88	8.55 ± 0.30	9.59 ± 0.27

Acrotylus humbertianus Saussure, 1884

Acrotylus humbertianus Saussure, 1884. *Mem. Soc. Phys. Hist. Nat. Geneve*. 28(9): 189.

Acrotylus humbertianus Saussure; Ingrisch, 1990. Spixiana (Munich). 13: 177.

Diagnostic characters: Wings with broad lunate fascia, area anterior to fascia with blackened venation while the area posterior to fascia faint yellow, wingspan big; one prominent fascia present on interno-medial disc of hind femora while fascia near hind knee not circular.

Distribution: INDIA: Andhra Pradesh, Bihar, Chhattisgarh, Delhi, Goa, Haryana, Himachal Pradesh, Jharkhand, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh, and West Bengal. ELSEWHERE: Afghanistan, Bangladesh, Nepal, Pakistan, and Sri Lanka.

Material Examined: Allahabad, 3♂, 4♀, 06.x.2010; Azamgarh, 4♂, 3♀, 08.x.2010; Kushinagar, 3♂, 2♀, 13.x.2010; Faizabad, 4♂, 5♀, 24.x.2010; Sultanpur, 4♂, 4♀, 25.x.2010; Hamirpur, 5♂, 4♀, 04.ix.2011; Jalaun, 3♂, 4♀, 05.ix.2011; Kanpur Dehat, 3♂, 2♀, 06.ix.2011; Kanpur Nagar, 3♂, 4♀, 07.ix.2011; Sitapur, 4♂, 4♀, 17.ix.2011; Aligarh, 3♂, 4♀, 01.viii.2012; Hathras, 5♂, 4♀, 02.viii.2012; Rampur, 3♂, 4♀, 15.viii.2012; Moradabad, 4♂, 3♀, 16.viii.2012; Bulandshahr, 3♂, 4♀, 18.viii.2012; Meerut, 5♂, 4♀, 21.viii.2012; Saharanpur, 5♂, 4♀, 23.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	18.24–23.56	22.67–25.82	20.93 ± 2.05	4.65 ± 1.20
Pronotum	4.61–5.36	4.84–5.76	4.95 ± 0.29	5.33 ± 0.38
Tegmina	19.03–22.34	23.30–25.20	20.99 ± 1.60	24.40 ± 0.87
Hind Femur	11.38–13.34	12.02–13.92	12.30 ± 0.75	13.12 ± 0.73

Gesonula punctifrons (Stal, 1861)

Acridium (*Oxya*) *punctifrons* Stal, 1861 [1860]. *Kongiga Svenska fregatten Eugenies Resa omkring jorden under befall af C.A. Virgin aren, 1851-1853(Zoologi)* 2(1): 336.

Gesonula punctifrons (Stal); Hongchang *et al.* 2006. *Fauna Sinica, Insecta* 43: 50.

Diagnostic characters: Pronotum subcylindrical, expanded posteriorly, acutely tectiform, prozona longer than metazona, dorso-lateral band extending behind the eyes continuing through pronotum; fastigium of vertex slightly longer than wide, weakly convex with acutely parabolic apex, median carinula absent; frons considerably oblique.

Distribution: INDIA: Andhra Pradesh, Andaman and Nicobar Islands, Arunachal Pradesh, Assam, Bihar, Chattisgarh, Delhi, Goa, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Odisha, Punjab, Tamil Nadu, Uttar Pradesh, and West Bengal. ELSEWHERE: Bangladesh, Borneo (Kalimantan), China (Hainan), Japan, Java, Malacca, Myanmar, North Vietnam, Philippines, Sri Lanka, Taiwan, and Thailand.

Material Examined: Ballia, 2♂, 3♀, 11.x.2010; Deoria, 2♂, 3♀, 12.x.2010; Kushinagar, 2♂, 2♀, 13.x.2010; Gorakhpur, 4♂, 3♀, 14.x.2010; Faizabad, 3♂, 4♀, 24.x.2010; Sultanpur, 2♂, 2♀, 25.x.2010; Hamirpur, 5♂, 4♀, 04.ix.2011; Kanpur Dehat, 3♂, 3♀, 06.ix.2011; Fatehpur, 3♂, 4♀, 11.ix.2011; Sitapur, 3♂, 3♀, 17.ix.2011; Meerut, 2♂, 2♀, 21.ix.2012; Saharanpur, 2♂, 1♀, 23.ix.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	21.48–23.29	22.14–24.06	22.56 ± 0.91	23.18 ± 0.64
Pronotum	4.20–4.81	4.51–5.32	4.53 ± 0.26	5.07 ± 0.40
Tegmina	19.43–21.51	21.74–23.11	20.21 ± 0.84	22.50 ± 0.61
Hind Femur	17.87–19.46	20.89–21.41	18.67 ± 0.60	21.34 ± 0.37

Oxya fuscovittata (Marschall, 1836)

Gryllus fuscovittatus Marschall, 1836. *Ann. Naturhist. Mus. Wien.* 1(2): 211.

Oxya fuscovittata (Marschall); Mishchenko, 1965. *Fauna of Russia Orthopt.* 148 (125).

Diagnostic characters: Body medium sized; integument almost smooth and shiny; fastigium of vertex short, wide, concave with obtusely parabolic apex, transverse furrow absent; hind tibiae with two rows of dorsal black-tipped spines, nine dorso-external while ten dorso-internal.

Distribution: INDIA: Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Goa, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Uttarakhand, Uttar Pradesh, and West Bengal. ELSEWHERE: Afghanistan, Bangladesh, Nepal, Pakistan, and South West Russia.

Material Examined: Azamgarh, 3♂, 3♀, 08.x.2010; Ghazipur, 4♂, 3♀, 09.x.2010; Mau, 4♂, 3♀, 10.x.2010; Gorakhpur, 3♂, 4♀, 14.x.2010; Deoria, 3♂, 4♀, 12.x.2010; Basti, 4♂, 4♀, 18.x.2010; Balrampur, 4♂, 5♀, 19.x.2010; Faizabad, 3♂, 4♀, 24.x.2010; Sultanpur, 2♂, 3♀, 25.x.2010; Hamirpur, 3♂, 4♀, 04.ix.2011; Fatehpur, 4♂, 4♀, 11.ix.2011; Sitapur, 5♂, 4♀, 17.ix.2011; Aligarh, 5♂, 4♀, 01.viii.2012; Meerut, 2♂, 3♀, 21.viii.2012; Saharanpur, 4♂, 3♀, 23.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	21.34–22.86	25.14–26.68	22.26 ± 0.81	26.06 ± 0.81
Pronotum	6.31–6.74	6.34–6.82	6.53 ± 0.21	6.56 ± 0.24
Tegmina	20.24–21.46	22–22.68	20.85 ± 0.61	22.42 ± 0.27
Hind Femur	13.42–14.46	16.26–17.17	14.00 ± 0.53	16.76 ± 0.46

Oxya velox (Fabricius, 1787)

Gryllus velox Fabricius, 1787. *Mantissa insectorum exhibens species nuper in Etruria collectas a Ptro Rossio.* 1: 239.

Oxya velox (Fabricius); Nayeem & Usmani, 2012. *Munis Entomology & Zoology* 7(1): 397.

Diagnostic characters: Head subconical; fastigium of vertex short, less widened, weakly concave, with apex obtusely parabolic, transverse furrow absent; frontal ridge uniformly sulcate, widened above median ocellus and uniformly narrowed below; prosternal process conical, basal half anteroposteriorly compressed, apex subacute rather than pointed, surface considerably hairy; hind tibiae with two rows of dorsal black-tipped spines.

Distribution: INDIA: Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Manipur, Meghalaya, Nagaland, Odisha, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, Uttarakhand, and West Bengal. ELSEWHERE: Bangladesh, China, Myanmar, Pakistan, Singapore, Sri Lanka, and Thailand.

Material Examined: Allahabad, 3♂, 3♀, 06.x.2010; Azamgarh, 3♂, 3♀, 08.x.2010; Deoria, 3♂, 3♀, 12.x.2010; Basti, 3♂, 2♀, 18.x.2010; Balrampur, 2♂, 2♀, 19.x.2010; Faizabad, 2♂, 3♀, 24.x.2010; Sultanpur, 4♂, 3♀, 25.x.2010; Hamirpur, 3♂, 3♀, 04.ix.2011; Fatehpur, 5♂, 4♀, 11.ix.2011; Sitapur, 4♂, 3♀, 17.ix.2011; Aligarh, 3♂, 4♀, 01.viii.2012; Meerut, 3♂, 3♀, 21.viii.2012; Saharanpur, 2♂, 2♀, 23.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	21.46–22.38	24.34–26.23	22.00 ± 0.69	25.41 ± 0.97
Pronotum	5.38–6.12	6.32–6.84	5.76 ± 0.37	6.57 ± 0.26
Tegmina	17.44–18.83	21.42–22.64	18.17 ± 0.48	22.13 ± 0.63
Hind Femur	13.76–14.82	15.47–16.94	14.31 ± 0.53	16.21 ± 0.73

Oxya hyla hyla Serville, 1831

Oxya hyla Serville, 1831. *Ann. Sci. nat.* 22 (86): 28–65, 134–167, 262–292.

Oxya hyla hyla (Serville); Nayeem & Usmani, 2012. *Munis Entomology & Zoology* 7(1): 397.

Diagnostic characters: Prosternal process subconical, anteroposteriorly compressed, apex obtuse; pronotum subcylindrical, median carina virtually obliterated in prozona, obtusely present in metazona; hind tibiae with eight dorso-external spines and ten dorso-internal spines.

Distribution: INDIA: Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Goa, Gujarat, Himachal Pradesh, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, Uttarakhand, and West Bengal. ELSEWHERE: Afghanistan, Angola, Bangladesh, Benin, Cameroon, Chad, Iran, and Zambia.

Material Examined: Allahabad, 3♂, 2♀, 06.x.2010; Azamgarh, 2♂, 2♀, 08.x.2010; Ghazipur, 4♂, 5♀, 09.x.2010; Mau, 4♂, 6♀, 10.x.2010; Deoria, 5♂, 7♀, 12.x.2010; Basti, 5♂, 4♀, 18.x.2010; Hamirpur, 5♂, 6♀, 04.ix.2011; Jalaun, 5♂, 4♀, 05.ix.2011; Fatehpur, 5♂, 3♀, 11.ix.2011; Sitapur, 6♂, 6♀, 17.ix.2011; Shahjahanpur, 4♂, 5♀, 14.ix.2012; Rampur, 4♂, 7♀, 15.viii.2012; Bulandshahr, 5♂, 6♀, 18.viii.2012; Meerut, 5♂, 4♀, 21.viii.2012; Saharanpur, 6♂, 7♀, 23.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	21.45–23.25	22.87–24.75	22.10 ± 0.79	24.93 ± 1.65
Pronotum	3.92–4.84	4.68–5.25	4.53 ± 0.33	5.03 ± 0.20
Tegmina	21.02–22.34	21.09–23.16	21.62 ± 0.47	22.14 ± 0.64
Hind Femur	20.41–21.37	20.45–21.43	20.72 ± 0.36	20.87 ± 0.42

Oxya hyla intricata (Stal, 1861)

Acridium (*Oxya*) *intricatum* Stal. 1861[1860]. *Kongliga Svenska fregatten Eugenies Resa omkring jorden under befal af C.A. Virgin aren* 1851-1853 (*Zoologi*) 2(1): 335

Oxya hyla intricata (Stal); Tan, Ngiam & Ismail, 2012. *Nature in Singapore* 5: 66

Diagnostic characters: Head conical; fastigium of vertex short, wide, broadly rounded with weak concavity, transverse semicircular furrow present; frontal ridge sulcate, slightly narrowing upwards with distinct parallel carinulae; prosternal process subconical, anteroposteriorly compressed, apex obtuse; pronotum subcylindrical, median carina virtually obliterated in prozona, obtusely present in metazoan.

Distribution: INDIA: Andhra Pradesh, Arunachal Pradesh, Himachal Pradesh, Manipur, Tripura, and Uttar Pradesh. ELSEWHERE: China, Java, Krakatau Island, Myanmar, Philippines Palaui Island, Ryukyu Island, Singapore, Sumatra, Taiwan, Thailand, Vietnam, and West Malaysia.

Material Examined: Azamgarh, 2♂, 1♀, 08.x.2010; Deoria, 3♂, 3♀, 12.x.2010; Basti, 3♂, 4♀, 18.x.2010; Faizabad, 3♂, 3♀, 24.x.2010; Sultanpur, 2♂, 3♀, 25.x.2010; Hamirpur, 5♂, 4♀, 04.ix.2011; Fatehpur, 4♂, 11.ix.2011; Sitapur, 4♂, 3♀, 17.ix.2011; Aligarh, 6♂, 5♀, 01.viii.2012; Shahjahanpur, 3♂, 5♀, 14.viii.2012; Saharanpur, 4♂, 4♀, 23.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	24.53–26.12	26.24–27.47	25.50 ± 0.85	26.83 ± 0.81
Pronotum	5.32–5.92	6.41–6.87	5.62 ± 0.30	6.62 ± 0.23
Tegmina	21.25–22.43	23.12–24.75	21.84 ± 0.59	23.90 ± 0.61
Hind Femur	15.38–16.56	17.62–18.78	16.05 ± 0.60	18.25 ± 0.58

Oxya japonica japonica (Thunberg, 1815)

Gryllus japonicas Thunberg, 1815. *Mem. Acad. Imp. Sci. St. Peterburg*. 5: 253.

Oxya japonica japonica (Thunberg); Nayeem & Usmani, 2012. *Munis Entomology & Zoology* 7(1): 397.

Diagnostic characters: Prosternal process anteroposteriorly flattened, apex conical; antennae filiform, as long as head and pronotum together; fastigium of vertex short, considerably wide, less concave, with apex rounded and slightly protruding, transverse furrow less prominent; hind tibiae nearly straight, flattened distally, distal half hairy, nine dorso-external spines and eleven dorso-internal spines; arolium of moderate size.

Distribution: INDIA: Assam, Bihar, Gujarat, Karnataka, Kerala, Manipur, Punjab, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh, and West Bengal. ELSEWHERE: Bangladesh, Bali, Borneo, Celebes, China, Halmahera Island, Hawaii, Japan, Java, Lombok, Myanmar, Pakistan Philippines, Palaui Island, Singapore, Sri Lanka, Sula, Sumba, Sumatra, Taiwan, Thailand, Timor, Vietnam, and West Malaysia.

Material Examined: Allahabad, 4♂, 3♀, 06.x.2010; Azamgarh, 2♂, 6♀, 08.x.2010; Deoria, 5♂, 6♀, 12.x.2010; Basti, 5♂, 5♀, 18.x.2010; Balrampur, 4♂, 5♀, 19.x.2010; Faizabad, 6♂, 4♀, 24.x.2010; Sultanpur, 5♂, 4♀, 25.x.2010; Hamirpur, 5♂, 8♀, 04.ix.2011; Fatehpur, 5♂, 5♀, 11.ix.2011; Sitapur, 4♂, 5♀, 17.ix.2011; Aligarh, 4♂, 2♀, 01.viii.2012; Shahjahanpur, 4♂, 5♀, 14.viii.2012; Rampur, 5♂, 4♀, 15.viii.2012; Meerut, 2♂, 4♀, 21.viii.2012; Saharanpur, 5♂, 7♀, 23.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	21.27–23.12	23.29–24.98	22.39 ± 0.98	24.20 ± 0.85
Pronotum	5.23–5.88	5.34–5.96	5.57 ± 0.32	5.64 ± 0.31
Tegmina	17.32–18.46	17.44–18.82	17.82 ± 0.58	18.20 ± 0.70
Hind Femur	13.4–14.84	13.93–14.78	14.20 ± 0.72	14.39 ± 0.43

Hieroglyphus nigrorepletus Bolivar, 1912

Hieroglyphus nigrorepletus Bolivar, 1912. *Trab. Mus. Cienc. nat., Madrid (Ser. zool.)*, 6: 56.

Hieroglyphus nigrorepletus Bolivar; Nayeem & Usmani, 2012. *Munis Entomology & Zoology* 7(1): 398.

Diagnostic characters: Medium to large sized; body robust and cylindrical; pronotum with sides markedly expanded in metazona; dorsum with characteristic black pattern connecting all sulci by two irregular stripes; first and third sulci joined by a black band.

Distribution: INDIA: Andhra Pradesh, Assam, Bihar, Delhi, Jammu & Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Uttarakhand, Uttar Pradesh, and West Bengal. ELSEWHERE: Bangladesh and Pakistan.

Material examined: Allahabad, 4♂, 5♀, 06.x.2010; Azamgarh, 5♂, 5♀, 08.x.2010; Ghazipur, 8♂, 7♀, 09.x.2010; Deoria, 5♂, 6♀, 12.x.2010; Kannauj, 5♂, 7♀, 09.ix.2011; Fatehpur, 15♂, 14♀, 11.ix.2011; Barabanki, 5♂, 6♀, 15.ix.2011; Sitapur, 10♂, 6♀, 17.ix.2011; Aligarh, 5♂, 4♀, 01.viii.2012; Shahjahanpur, 8♂, 5♀, 14.viii.2012; Moradabad, 5♂, 6♀, 16.viii.2012; Bulandshahr, 6♂, 7♀, 18.viii.2012; Saharanpur, 8♂, 8♀, 23.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	32.46–38.51	36.01–41.52	35.77 ± 2.01	39.22 ± 1.84
Pronotum	7.49–8.03	7.86–9.32	8.18 ± 0.48	8.79 ± 0.63
Tegmina	12.35–16.67	16.53–19.16	14.69 ± 1.52	18.15 ± 0.91
Hind Femur	16.30–18.19	17.62–19.78	17.41 ± 0.73	18.72 ± 0.77

Hieroglyphus banian (Fabricius, 1798)

Gryllus banian Fabricius, 1798. *Supplementum Entomologiae Systematicae Suppl*. 194.

Hieroglyphus banian (Fabricius); Nayeem & Usmani, 2012. *Munis Entomology & Zoology* 7(1): 398.

Diagnostic characters: Body medium to large sized; head globular in profile; fastigium of vertex short, as long as wide in males, wider than long in females; pronotum shiny, overall smooth with fine punctations in metazona and as band beneath anterior pronotal margin in prozona, lateral carinae absent; prosternal process small in size, conical with subacute apex.

Distribution: INDIA: Andhra Pradesh, Bihar, Himachal Pradesh, Maharashtra, Odisha, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh, and West Bengal. ELSEWHERE: Afghanistan, Bangladesh, Bhutan, China, Myanmar, Nepal, Thailand, and Vietnam.

Material examined: Azamgarh, 6♂, 7♀, 08.x.2010; Ghazipur, 3♂, 4♀, 09.x.2010; Deoria, 4♂, 4♀, 12.x.2010; Faizabad, 3♂, 3♀, 24.x.2010; Kannauj, 4♂, 4♀, 09.ix.2011; Auraiya, 2♂, 3♀, 10.ix.2011: Fatehpur, 4♂, 4♀, 11.ix.2011; Sitapur, 4♂, 3♀, 17.ix.2011; Aligarh, 5♂, 6♀, 01.viii.2012; Rampur, 3♂, 4♀, 15.viii.2012; Moradabad, 4♂, 3♀, 16.viii.2012; Meerut, 5♂, 6♀, 21.viii.2012; Saharanpur, 4♂, 5♀, 23.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	38.57–42.54	47.68–53.72	40.63 ± 1.98	50.96 ± 3.05
Pronotum	7.24–8.85	8.74–10.22	8.14 ± 0.82	9.51 ± 0.74
Tegmina	27.69–30.57	34.53–37.48	29.19 ± 1.44	36.16 ± 1.50
Hind Femur	18.45–19.84	22.38–25.22	19.21 ± 0.70	23.99 ± 1.45

***Spathosternum prasiniferum prasiniferum* (Walker, 1871)**

Heteracris prasinifera Walker, 1871. *Catalogue of the Specimens of Dermaptera Saltatoria in the Collection of the British Museum*. 5: 65.

Spathosternum prasiniferum (Walker); Nayeem & Usmani, 2012. *Munis Entomology & Zoology* 7(1): 398.

Diagnostic characters: Body small sized; fastigium of vertex wide, slightly depressed, apex parabolic; frons strongly oblique; pronotum coarsely tectiform, dorsum flattened with three transverse sulci.

Distribution: INDIA: Andaman & Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Uttar Pradesh, and West Bengal. ELSEWHERE: Bangladesh, Myanmar, Nepal, Pakistan, South and East China, Hainan, Sri Lanka, Thailand, Vietnam, and West Malaysia.

Material Examined: Faizabad, 5♂, 5♀, 24.x.2010; Sultanpur, 5♂, 6♀, 25.x.2010; Pratapgarh, 5♂, 4♀, 26.x.2010; Mahoba, 5♂, 7♀, 03.ix.2011; Hamirpur, 5♂, 4♀, 04.ix.2011; Jalaun, 5♂, 4♀, 05.ix.2011; Kanpur Dehat, 5♂, 6♀, 06.ix.2011; Bulandshahr, 4♂, 4♀, 18.viii.2012; Gautam Buddh Nagar, 4♂, 4♀, 19.viii.2012; Jyotiba Phule Nagar, 4♂, 4♀, 20.viii.2012; Meerut, 5♂, 6♀, 21.viii.2012; Muzaffarnagar, 6♂, 3♀, 22.viii.2012; Saharanpur, 5♂, 4♀, 23.viii.2012; Baghpat, 3♂, 3♀, 24.viii.2012; Bijnor, 4♂, 6♀, 25.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	14.13–15.46	18.46–19.68	14.94 ± 0.71	19.16 ± 0.82
Pronotum	3.16–3.79	4.25–4.89	3.46 ± 0.31	4.56 ± 0.32
Tegmina	11.35–12.62	13.25–14.32	12.09 ± 0.66	14.16 ± 0.74
Hind Femur	8.37–9.54	9.38 – 10.45	8.95 ± 0.58	10.20 ± 0.61

***Eyprepocnemis alacris alacris* (Serville, 1838)**

Acridium alacre Serville, 1838[1839]. *Histoire naturelle des insectes. Orthopteres*. 682.

Eyprepocnemis alacris alacris (Serville); Nayeem & Usmani, 2012. *Munis Entomology & Zoology* 7(1): 402.

Diagnostic characters: Body medium sized; fastigium of vertex longer than wide, frons oblique; frontal ridge moderately wide, weakly convex; pronotum apparently smooth with metazona strongly tectiform and slightly expanded; prosternal process moderate in size, anteroposteriorly flattened, slightly bent towards mesosternum; hind tibiae straight with two rows of ten black-tipped spines each; spurs not specialized.

Distribution: INDIA: Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Goa, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Odisha, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, and West Bengal. ELSEWHERE: Afghanistan, Bangladesh, Iran, Iraq, Pakistan, and Sri Lanka.

Material Examined: Gorakhpur, 2♂, 3♀, 14.x.2010; Jhansi, 4♂, 3♀, 01.ix.2011; Lalitpur, 4♂, 4♀, 02.ix.2011; Mahoba, 4♂, 4♀, 03.ix.2011; Hamirpur, 5♂, 8♀, 04.ix.2011; Jalaun, 6♂, 4♀, 05.ix.2011; Kannauj, 5♂, 6♀, 09.ix.2011; Aligarh, 3♂, 4♀, 01.viii.2012; Ghaziabad, 5♂, 4♀, 17.viii.2012; Bulandshahr, 5♂, 4♀, 18.viii.2012; Meerut, 2♂, 3♀, 21.viii.2012; Saharanpur, 4♂, 3♀, 23.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	30.38–33.22	34.46–38.24	31.76 ± 1.42	36.51 ± 1.91
Pronotum	5.66–6.48	6.74–7.53	6.09 ± 0.47	7.04 ± 0.42
Tegmina	25.22–26.86	28.24–29.88	26.14 ± 0.83	29.15 ± 0.83
Hind Femur	16.65–18.77	21.56–22.58	17.65 ± 1.06	22.16 ± 0.53

***Xenocatantops karnyi* (Kirby, 1910)**

Catantops karnyi Kirby, 1910. *A Synonymic Catalogue of Orthoptera* (*Orthoptera Saltatoria, Locustidae vel Acridiidae*). 3(2): 483.

Xenocatantops karnyi (Kirby); Nayeem & Usmani, 2012. *Munis Entomology & Zoology* 7(1): 403.

Diagnostic characters: Body small sized; integument finely rugose; pronotum finely rugose and tectiform; hind femora slightly robust, not exceeding abdomen, upper carina with black-tipped serrations, upper external carinula with intermittent black-tipped tubercles, externo-medial disc with two broad prominent fuscous spots continued to upper region of interno-medial disc, faded dorsally, lower external carinula with contiguous black stripe beneath extending over it in a regular fashion; hind tibiae slightly hairy with two rows of dorsal black-tipped spines; arolium small.

Distribution: INDIA: Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Delhi, Himachal Pradesh, Maharashtra, Odisha, Tamil Nadu, Tripura, Uttarakhand, and Uttar Pradesh. ELSEWHERE: Nepal.

Material Examined: Azamgarh, 3♂, 4♀, 08.x.2010; Deoria, 4♂, 4♀, 12.x.2010; Kushinagar, 4♂, 5♀, 13.x.2010; Fatehpur, 2♂, 4♀, 11.ix.2011; Aligarh, 2♂, 4♀, 01.viii.2012; Meerut, 4♂, 2♀, 21.viii.2012; Saharanpur, 5♂, 4♀, 23.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	26.32–27.76	28.63–30.42	27.16 ± 0.75	29.50 ± 0.89
Pronotum	4.92–5.43	5.12–5.97	5.15 ± 0.25	5.52 ± 0.42
Tegmina	19.54–20.32	20.27–21.96	19.91 ± 0.39	21.24 ± 0.87
Hind Femur	12.32–12.95	13.56–14.73	12.64 ± 0.31	14.27 ± 0.62

Diabolocatantops pinguis **(Stal, 1861)**

Acridium pingue Stal, 1861 [1860]. *Kongliga Svenska fregatten Eugenies Resa omkring jorden under befal af C.A. Virgin aren 1851-1853* (*Zoologi*) 2(1): 330.

Diabolocantops pinguis (Stal); Nayeem & Usmani, 2012. *Munis Entomology & Zoology* 7(1): 403.

Diagnostic characters: Head obtusely conical; fastigium of vertex wide, trapezoidal; fastigial foveolae lacking; frontal ridge flat, depressed at median ocellus with obtuse virtually parallel lateral carinulae; pronotum finely tectiform, median carina obtusely present, crossed with equal intensity by three transverse sulci, lateral carinae absent; prosternal process cylindrical with flat apex; mesosternal interspace open, moderately wide, lobes rounded, slightly wider than long.

Distribution: INDIA: Jammu & Kashmir, Kerala, Manipur, Rajasthan, Sikkim, Tamil Nadu, and Uttar Pradesh. ELSEWHERE: Cambodia, China (Hainan), Japan, Myanmar, Sri Lanka, and Taiwan.

Material Examined: Allahabad, 2♂, 3♀, 06.x.2010; Deoria, 4♂, 3♀, 12.x.2010; Jhansi, 2♂, 4♀, 01.ix.2011; Hamirpur, 3♂, 3♀, 04.ix.2011; Aligarh, 4♂, 4♀, 01.viii.2012; Hathras, 5♂, 3♀, 02.viii.2012.

Morphometry:

Measurement (mm)	Male	Female	Mean ± SD	
			Male	Female
Body length	28.74–30.17	31.69–33.12	29.60 ± 0.75	32.51 ± 0.73
Pronotum	5.04–5.98	6.13–6.97	5.56 ± 0.47	6.51 ± 0.42
Tegmina	21.04–21.89	23.35–24.48	21.50 ± 0.42	23.92 ± 0.56
Hind Femur	12.31–12.97	14.34–14. 86	12.61 ± 0.33	14.56 ± 0.26

DISCUSSION

Grasshoppers have chewing mouthparts and are commonly thought of as foliage feeders, but they also feed on flowers, fruits, seed heads, stems, and essentially all aerial plant parts, causing considerable damage to agricultural crops, pastures, and forests (Joshi *et al.* 1999). Though generalist, eating plants from a broad range of families depending upon the availability in their habitat (Gangwere 1961), they are primarily graminivorous (Joern 1979). Host preferences, feeding behaviour and even habitat of different species of grasshoppers among the subfamilies vary and are indicators of different ecosystems.

Grasshoppers are widely distributed in paddy fields in Uttar Pradesh. Both nymphs and adults feed vigorously on rice foliage, leaving the bare stems, resulting in drying of leaves and plants. The adults cause seven to eight times more damage than the nymphs. Some species cause severe defoliation that restricts the growth, leaving lean stems with few leaves, resulting low or no rice yield, thus they may be considered as major pests of rice.

Grasses have poor nutrition as compared to other crops (Tscharntke and Greiler 1995) hence grasshoppers tend to move on crops or other mixture of plants for their nutritional requirements for better growth and reproduction (Behmer and Joern 1993). Vegetation pattern is more important regarding the species composition, disturbed area having less species number and abundance as compared to the undisturbed area (Kemp *et al.* 1990). Grasshopper damages all stages of paddy crop. Both nymphs and adults can feed on leaves by cutting the edges of leaves. When found in huge numbers, they can feed even on the midribs and entire leaves, and cause extensive defoliations.

The impressive growth of Indian agriculture has helped the county achieve food security at national level. To sustain this growth and achieve nutritional security, it is necessary to further study the Acridid pests of rice crops and their control measures, to increase rice yield.

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A REPORT OF EREBIDAE (LEPIDOPTERA: NOCTUOIDEA) FROM THE TAMIL NADU PART OF THE WESTERN GHATS, INDIA

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In a study on the Erebidae of the Tamil Nadu part of the Western Ghats, 67 species were collected of which two species are new records for the state and one species is new to India. The material collected, habits and habitats of these species, and geographical details are presented.

Key words: Taxonomy, Erebidae, Western Ghats, Tamil Nadu

INTRODUCTION

The family Erebidae was separated from family Noctuidae in the 1990s, based on the results from molecular research which provided increasingly robust support for a close relationship between the Arctiidae and the quadrifid subfamilies of the Noctuidae (Mitchell *et al.* 1997, 2000; Weller *et al.* 1994), indicating that the Noctuidae are paraphyletic with respect to the Arctiidae and Lymantriidae (=Lymantriinae). The family name Erebidae was coined for the "quadrifid noctuids" which includes the subfamilies Catocalinae and Erebinae. Fibiger and Lafontaine (2004) have treated the quadrifid subfamilies (Herminiinae, Hypenodinae, Hypeninae, Catocalinae, Calpinae, Hypeninae, Stictopterinae, and Euteliinae) as subfamilies of the re-established family Erebidae. The recent classification places Calpinae in the family Erebidae (Fibiger and Lafontaine 2004). Calpinae now consists of three tribes: Calpini Boisduval, Phyllodini Hampson, and Ophiderini Guenée.

The family Erebidae is characterized by: i) the vein M_2 in the hindwing being strongly developed in the lower part of the cell, so that the cubital vein appears to be four-branched; ii) having no basal abdominal brushes which are derived characters found in most of the subfamilies in Noctuidae; iii) Scales on the ventral half of the frons deciduous, quickly fall off to leave the area bare in most Erebids.

Most Erebidae are phytophagous as larvae and nectar sucking as adults, and function as herbivores, pollinators, and prey, as well as one of the most damaging groups of agricultural pests (Reiger *et al.* 2009). The adults of some genera damage fruit crops by piercing the skin to suck juice (Banziger 1982).

The Western Ghats (8° 20′–20° 40′ N; 73°–77° E) is one of the mega biodiversity hotspots in the subtropical region. The habitat types in this region include scrub, dry deciduous, moist deciduous, semi-evergreen, evergreen, montane temperate, and grasslands. The Tamil Nadu part of the Western Ghats consists of the Nilgiri Biosphere Reserve, Kodaikanal, and Palani Hills. The Nilgiri Biosphere Reserve (10° 45′–12° N; 76°–77° 15′ E; area: 5,520 sq. km), which is one among the 18 hotspots in the world, is situated in the Western Ghats. Altitude within the Nilgiri Biosphere Reserve varies from 250 m to 2,670 m. Kodaikanal hills (10° 14′ 6″ N; 77° 29′ 6″ E; area: 21.45 sq. km) situated in Dindigul district, Tamil Nadu, form the eastern region of the Western Ghats. This paper presents a tentative list of the Erebidae from the Tamil Nadu part of Western Ghats, with illustrations. This is the first study documenting the Erebidae from the Tamil Nadu part of the Western Ghats Nilgiri Biosphere (Table 1) and the proposed Kodaikanal Wildlife Sanctuary (Table 2).

MATERIAL AND METHODS

Collections were made using mercury vapour light source during five-day periods at 26 sites every month from 2008 to 2012. This study is based primarily on the collections carried out by the Entomology Research Institute (ERI), Loyola College, Chennai, Tamil Nadu. Voucher specimens were deposited at Entomology Research Institute, Loyola College, Chennai, Tamil Nadu, India. Photographs of the adult moths were taken with digital cameras, and the plates were compiled using Adobe Photoshop software. The specimens were identified using the keys provided by Hampson (1894) and Moore (1881). We have made taxonomic changes in the Noctuoidea by referring to Lafontaine and Schmidt (2010).

Table 1: Collection sites of Family Erebidae from the Kodaikanal hills

No	Locality	Latitude	Longitude	Elev. ft/m
1	Kodaikanal Bus Terminus	10° 23′ 5367˝ N	77° 49′ 2933˝ E	6983/2130
2	Perumalmalai (site 1)	10° 26′ 4066˝ N	77° 53′ 3633˝ E	5127/1563
3	Perumalmalai (site 2)	10° 27′ 045˝ N	77° 53′ 3633˝ E	4934/1504
4	Observatory	10° 22′ 9166˝ N	77° 45′ 95˝ E	7529/2295
5	Poomparai	10° 24′ 705˝ N	77° 40′ 4˝ E	6320/1926
6	Pallangi	10° 27′ 3233˝ N	77° 45′ 2316˝ E	5461/1665
7	Mattupatti	10° 27′ 375˝ N	77° 45′ 54˝ E	5511/1680
8	Moonjikal	10° 23′ 915˝ N	77° 49′ 7716˝ E	6700/2030
9	Bear Shola	10° 24˝ N	77° 48′ 0283˝ E	6908/2106
10	Bryant Park	10° 23′ 0983˝ N	77° 49′ 4483˝ E	6987/2130
11	Kodaikanal Lake	10° 23′ 8383˝ N	77° 48′ 7683˝ E	6894/2101
12	Coaker's Walk	10° 23′ 0983˝ N	77° 49′ 4483˝ E	6987/2130
13	Senbaganur	10° 23′ 1733˝ N	77° 50′ 3˝ E	5899/1798
14	Vattakanal	10° 21′ 5166˝ N	77° 48′ 5266˝ E	6825/2080
15	Vellagavi	10° 19′ 7033˝ N	77° 49′ 9183˝ E	4408/1343

Table 2: Collection sites of Family Erebidae from the Nilgiri Biosphere Reserve

No	Locality	Latitude	Longitude	Elev.ft/m
1	Ooty Botanical Garden	11° 41′ 758″ N	76° 71′ 048″ E	7306/2228
2	Benchmark Tea Estate	11° 41′ 181″ N	76° 72′ 07″ E	7840/2389
3	Doddabetta	11° 40′ 116″ N	76° 73′ 58″ E	8607/2624
4	Ooty Lake	11° 40′ 45″ N	76°69′ 0933″ E	7286/2221
5	Coonoor Municipal building	11° 33′ 916N	76° 80′ 175″ E	5539/1686
6	Sim's Park	11° 35′ 485″ N	76° 80′ 03″ E	6082/1855
7	Ketti	11° 38′ 211″ N	76° 73′ 745″ E	7014/2137
8	Ithalar	11° 34′ 275″ N	76° 63′ 566″ E	6932/2112
9	Emerald Dam	11° 32′ 636″ N	76° 61′ 995″ E	6596/2009
10	Avalanche	11° 30′015″ N	76° 59′ 083″ E	6579/2005
11	Kothagiri Pandian Park	11° 42′ 155″ N	76° 85′ 006″ E	6218/1897

RESULTS

An account of moths collected in this study is given below under their respective taxonomic categories. Altogether, 67 species of Erebidae were collected by K. Sivasankaran of Entomology Research Institute, during this study in Tamil Nadu part of the Western Ghats. Among the specimens collected, three species namely *Phyllodes consobrina* Westwood (Phyllodini), *Lygniodes hypoleuca* Guenée (Erebini), and *Hyperlopha crucifera* Walker (Hypopyrini) were reported for the first time from the state. For the nomenclature, we have followed Kononenko and Pinratana (2005).

Subfamily: Scoliopteryginae

Tribe: Anomini

***Gonitis mesogona* Walker, [1858] 1857**

Gonitis mesogona Walker, [1858] 1857, *List Specimens lepid. Insects Colln Br. Mus.* 13: 1002.

Anomis mesogona Walker; Holloway, 1976: 37.

Material in the collection: 03.ix.2009, 7 ex.; 07.ix.2010, 8 ex.; 11.x.2010, 15 ex.; 12.ix.2011, 4 ex.; 07.x.2011, 3 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Coonoor Municipal building, Sim's Park, and Kethi. Kodaikanal: Bus Terminus, Moonjikal, Bryant Park, and Bear Shola.

Distribution: India, Thailand, Malaysia, Korea, Japan (Honshu, Shikoku, Kyushu, Tsushima Islands), China, South of Russian Far East (migrant), Nepal, Pakistan, Philippines, Indonesia, Sri Lanka.

***Gonitis involuta* Walker, [1858] 1857**

Gonitis involuta Walker, [1858] 1857, *List Specimens lepid. Insects Colln Br. Mus.* 13: 1003.

Gonitis basalis Walker, [1858] 1857, *List Specimens lepid. Insects Colln Br. Mus.* 13: 1004.

Tiridata colligata Walker, 1857, *List Specimens lepid. Insects Colln Br. Mus.* 33: 870.

Gonitis vitiensis Butler, 1886, *Trans. ent. Soc. London* 1886: 408.

Gonitis basalis Butler, 1886, *Trans. ent. Soc. London* 1886: 408.

Cosmophila dona Swinhoe, 1919, *Ann. Mag. Nat. Hist.* (9)3: 313.

Anomis brima Swinhoe, 1920, *Ann. Mag. Nat. Hist.* (9)5: 255.

Material in the collection: 15.iv.2008, 23 ex.; 26.iv.2009, 7 ex.; 07.vi.2009, 12 ex.; 29.iv.2010, 21 ex.; 15.xii.2010, 14 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Coonoor Municipal building, Sim's Park, and Kethi. Kodaikanal: Bus Terminus, Moonjikal, Bryant Park, and Bear Shola.

Distribution: India, Thailand, Indochina, Nepal, Pakistan, Afganistan, China, Taiwan, Australia, Vanuatu, Korea, South of Russian Far East (migrant), Indonesia (New Guinea, New Caledonia, Fiji [Rotuma], Bismarck Is., Solomon Is.), Oceania.

***Rusicada privata* (Walker, 1865)**

Rusicada privata (Walker, 1865), *List Specimens lepid. Insects Colln Br. Mus.* 33: 863.

Gonitis commode Butler, 1878, *A.M.N.* 4(5) i: 203.

Gonitis metaxantha Walker, 1857, *Cat.* xiii: 1005.

Gonitis guttanivis Walker, 1857, *Cat.* xiii: 1003.

Gonitis combinans Walker, 1857, *Cat.* xiii: 1001.

Gonitis privata Walker, 1862, *Cat.* xxxiii: 863.

Gonitis revocan, Walker, 1858, *Cat.* xv: 1794.

Gonitis vulpine Butler, 1886, *Tr. Ent. Soc.* 408.

Gonitis xanthochroa Butler, 1886, *Tr. Ent. Soc.* 409.

Gonitis inducens Walker, 1862, *Cat.* xxxiii: 864.

Diremma simulatrix Walker, 1862, *Cat.* xxxiii: 864,

Gonitis albitibia Walker, 1857, *Cat.* xiii: 1001.

Rusicada nigritarsis Walker, 1857, *Cat.* xiii: 1006; Moore, 1887, *Lep. Ceyl.* iii: pl. 155.

Rusicada subfulvida Warren, 1913, in Seitz, Macrolepid. World 3: 360, pl. 66.

Rusicada griseolineata Warren, 1913, in Seitz, Macrolepid. World 3: 360, pl. 66.

Cosmophila fulvida Guenee, 1852, *Noct.* ii: 397; Moore, 1882, *Lep. Ceyl.* ii: pl. 155; Hampson, 1894, *Faun. Brit. Ind.* ii: 409.

Material in the collection: 15.iv.2008, 13 ex.; 26.iv.2009, 7 ex.; 07.vi.2009, 12 ex.; 29.iv.2010, 21 ex.; 15.xii.2010, 4 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Coonoor Municipal building, Sim's Park, and Kethi. Kodaikanal: Bus Terminus, Moonjikal, Bryant Park, and Bear Shola.

Distribution: India, Thailand, Indochina, Korea, Japan, China, South Russian Far East (migrant), Australia, Sri Lanka, North America (introduced).

***Anomis flava* (Fabricius, 1775)**

Anomis flava (Fabricius, 1775), *Syst. Ent.*: 601.

Material in the collection: 15.iv.2008, 4 ex.; 26.iv.2010, 2 ex.; 07.x.2011, 3 ex.; 15.xii.2012, 4 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Coonoor Municipal building, Sim's Park, and Kethi. Kodaikanal: Bus Terminus, Moonjikal, Bryant Park, and Bear Shola.

Distribution: India, Thailand, Indochina, Nepal, Pakistan, China, Taiwan, Japan, Korea, South Russian Far East, Philippines, Micronesia, Indonesia (Samoa, Tonga, New Caledonia Solomon Is.), Vanuatu, Tasmania, New Zealand, Saudi Arabia, Oman, Morocco, Africa, South of Sahara, Madagascar, Mauritius, Hawaii, North America (introduced).

Subfamily: Calpinae Boisduval, 1840

Tribe: Calpini

***Plusiodonta coelonota* (Kollar, [1844])**

Plusiodonta coelonota (Kollar, [1844]), in *Hugel, Kaschmir und das Reich der Siek* 4: 482

Material in the collection: 09.v.2010, 3 ex.; 27.v.2011, 2 ex.; 24.v.2012, 3 ex.

Collection Localities: Kodaikanal: Bus Terminus, Bryant Park, and Moonjikal.

Distribution: India, Thailand, Malaysia, Vietnam, Nepal, Sri Lanka, Indonesia (Java, Sumatra, Timor, Flores), China, Taiwan, Japan, Korea.

***Calyptra minuticornis* (Guenée, 1852)**

Calpe minuticornis Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 6: 374.

Calpe novaepommeraniae Strand, 1919, *Arch. Naturgesch.*, 83A (10): 143.

Calpe minuticornis Guenée; Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 38.

Material in the collection: 15.iv.2008, 5 ex.; 26.iv.2009, 9 ex.; 27.v.2010, 7 ex.; 5.v.2012, 8 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, and Coonoor Municipal building. Kodaikanal: Bryant Park, Moonjikal, and Bear Shola.

Distribution: India, Nepal, Sri Lanka, Taiwan, Thailand, Malaysia, Indonesia (Java, Timor, Flores, Sumbawa, Borneo, New Guinea, Bismarck Is., Sulawesi), China, Japan, New Britian, Rook Island, Papua Guinea (Oomsis), Australia (Queensland).

***Oraesia emarginata* (Fabricius, 1794)**

Noctua emarginata Fabricius, 1794, *Ent. Syst.* III, 2: 82.

Oraesia metallescens Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 6: 364.

Oraesia alliciens Walker, [1858] 1857, *List Spec. lepid. Insects Colln Br. Mus.* 12: 945.

Oraesia tentans Walker, [1858] 1857, *List Spec. lepid. Insects Colln Br. Mus.* 12: 954.

Oraesia camaguina Swinhoe, 1918, *Ann. Mag. Nat. Hist.* (9), 2: 90.

Calpe emarginata Fabricius; Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 38.

Material in the collection: 15.iv.2008, 5 ex.; 26.iv.2009, 9 ex.; 27.vi.2010, 7 ex.; 5.x.2012, 11 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Doddabetta, Sim's Park, and Coonoor Municipal building. Kodaikanal: Moonjikal, Bryant Park, Bear Shola, and Senbaganur.

Distribution: India, Korea, Japan (Honshu, Shikoku, Kyushu, Tsushima Is.), China, Tibet, East Africa, Taiwan, Philippines, Indonesia (Sulawesi, Borneo).

Tribe: Ophiderini Guenée, 1852

***Eudocima materna* Linnaeus, 1767**

Material in the collection: 03.ix.2009, 13 ex.; 07.ix.2010 4 ex.; 05.ix.2011, 5 ex.; 04.ix.2012, 9 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Ooty Lake, Doddabetta, Sim's Park, and Coonoor Municipal building.

Distribution: India, Sri Lanka, Myanmar, Indonesia (Java, New Guinea), Australia.

***Eudocima salaminia* (Cramer, 1777)**

Noctua salaminia Cramer, [1777] 1779, *Uitlandsche Kapellen* 2: 117.

Eudocima salaminia Cramer; Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 36.

Material in the collection: 09.v.2009, 12 ex.; 28.vi.2010, 8 ex.; 15.xii.2012, 11 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Doddabetta, Sim's Park, and Coonoor Municipal building. Kodaikanal: Moonjikal, Bryant Park, Bear Shola, and Senbaganur.

Distribution: India, Thailand, Indochina, Nepal, China, Taiwan, Japan, Korea (tropical migrant), Philippines, Indonesia (Java, Sumatra, New Guinea), Micronesia, Central Africa, Australia.

***Eudocima* [*Adris*] *sikhimensis* (Butler, 1895)**

Adris sikhimensis Butler, 1895, *Ann. Mag. Nat. Hist.* (6), 15: 1260.

Othreis abathyglypta Prout, 1928, *Bull. Hill Mus. Witley* 2: 264.

Othreis abathyglypta Prout; Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 36.

Material in the collection: 15.iv.2008, 2 ex.; 27.vi.2010, 3 ex.; 5.ix.2012, 4 ex.

Collection Localities: Kodaikanal.

Distribution: India, Thailand, Myanmar, Malaysia, Nepal, Bhutan, Indonesia (Borneo, Sumatra, Bali).

***Eudocima* [*Othreis*] *phalonia* Linnaeus [*fullonia* Clerck, 1764]**

Phalaena (*Noctua*) *phalonia* Linnaeus, 1763, *Centuria Insectorum rariorum*: 28.

Phalaena fullonia Clerck, [1764] 1759, *Icones Insect. rariorum* pl. 48, ff. 1–4.

Phalaena (*Attacus*) *fullonica* Linnaeus, 1767, *Syst. Nat.* (ed. 12): 812.

Noctua dioscoreae Fabricius, 1775, *Syst. Ent.*: 593. *Phalaena* (*Noctua*) *pomona* Cramer, [1775] 1779, *Uitlandsche Kapellen* 1: 122.

Ophideres princeps Boisduval, 1832, *in* d'Urville *Voyage de Découvertes de l'Astrolabe* Pl 1: 245.

Ophideres obliterans Walker, 1857, *List Spec. lepid. Insects Colln Br. Mus.* 13: 1229.

Othreis fullonia Clerck; Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 36.

Material in the collection: 26.iv.2008, 2 ex.; 06.iv.2009, 4 ex.; 09.v.2009, 6 ex.; 15.iv.2010, 3 ex.; 27.v.2010, 3 ex.; 03.ix.2010, 3 ex.; 13.x.2010, 4 ex.; 15.xii.2010, 3 ex.; 8.iv.2011, 2 ex.; 23.v.2011, 12 ex.; 07.ix.2011. 5 ex.; 07.x.2011, 4 ex.; 09.xii.2011, 3 ex.; 26.iv.2012, 4 ex.; 2.v.2012, 7 ex.; 29.ix.2012, 2 ex.; 15.x.2012, 3 ex.; 07.xii.2012, 4 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Ooty Lake, Doddabetta, Sim's Park, Coonoor Municipal building, Nonsuch, and Kothagiri. Kodaikanal: Moonjikal, Bryant Park, Bear Shola, and Senbaganur.

Distribution: India, Thailand, Myanmar, Vietnam, Nepal, China, Taiwan, Japan, Korea, South of Russian Far East (migrant), Philippines, Indonesia (New Guinea), Micronesia, Australia, New Zealand, Central Africa (Gabon, Zaire, Congo).

***Eudocima* [*Othreis*] *homaena* (Hübner, [1823] 1816)**

Othreis homaena Hübner, [1827] 1816, *Verz. Bekannter Schmett.*: 264.

Phalaena (*Noctua*) *ancilla* Cramer, 1777, *Uitlandsche Kapellen* 2: 84.

Phalaena strigata Donovan, [1804] 1800, *Epitome Nat. Hist. Insects Ind.* pl. 54: fig. 2.

Ophideres bilineosa Walker, [1858] 1857, *List Spec. lepid. Insects Colln Br. Mus.* 13: 1227.

Othreis ancilla formosana Okano, 1964, *Tohoku Konchu Kenkyu* 1(2): 43–4.

Othreis homaena Hübner; Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 36.

Material in the collection: 15.iv.2008, 3 ex.; 09.iv.2009, 2 ex.; 07.v.2009, 1 ex.; 03.iv.2010, 2 ex.; 16.iv.2010, 2 ex.; 27.v.2010, 3 ex.; 03.x.2010, 3 ex.; 07.x.2010, 2 ex.; 15.xii.2010, 2 ex.; 05.v.2011, 1 ex.; 29.xii.2012, 4 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Ooty Lake, Doddabetta, Sim's Park, and Coonoor Municipal building; Kodaikanal: Moonjikal, Bryant Park, Bear Shola, and Senbaganur.

Distribution: India, Nepal, Taiwan, Vietnam, Malaysia, Sri Lanka, Philippines, Australia (Christmas Island), Indonesia (Borneo, Timor, Flores), China, Japan.

***Eudocima cajeta* (Cramer, 1779)**

Eudocima cajeta (Cramer, 1779), *Papilio exot.* 1: 48, Pl.30.

Eudocima multiscripta Walker, 1857, *List Specimens lepid. Insects Colln. Br. Mus.*13: 1226.

Material in the collection: 15.iv.2008, 1 ex.; 09.iv.2009, 2 ex.; 07.v.2009, 1 ex.; 03.iv.2010, 2 ex.; 16.iv.2010, 1 ex.; 27.v.2010, 2 ex.; 05.v.2011, 1 ex.

Collection Localities: Kodaikanal: Moonjikal, Bryant Park, and Bear Shola.

Distribution: India, Thailand, Vietnam, Sri Lanka, Indonesia (Sumatra, Java, Borneo, Sulawesi, Batavia, Moluccas, Seram), Philippines.

***Eudocima* [*Khadira*] *aurantia* (Moore, 1877)**

Ophideres aurantia Moore, 1877, *Proc. zool. Soc. Lond.* 1877: 607.

Adris rutilus Moore, 1881, *Trans. zool. Soc. Lond.* 11: 70.

Khadira aurantia Moore; Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 36.

Material in the collection: 31.iii.2010, 2 ex.; 26.iii.2011, 1 ex.; 05.iii.2012, 2 ex.

Collection Localities: Nilgiri Biosphere Reserve: Benchmark Tea Museum.

Distribution: India, Sri Lanka, China, Andaman Islands, Indonesia (Sulawesi, Seram, New Guinea, Solomon Is.), Australia (Queensland).

Tribe: Phyllodini Guenée, 1852

Phyllodes consobrina Westwood, 1848*

Phyllodes consobrina Westwood, 1848, *Cab.Or. Ent.* pl. 28, fig. 2. p. 57.

Phyllodes perspicillator Guenee, 1852, *Guen. Noct.* iii, p. 120.

Phyllodes maligera Butl. *Ent. Mon. Mag.* xx, p. 138.

Phyllodes roseigera Butl. *P.Z.S.* 1883, p. 164.

Material in the collection: 20.vii.2010, 2 ex.; 18.vii.2011, 1 ex.

Collection Localities: Kodaikanal: Bus Terminus.

Distribution: India, Thailand, Malaysia, Indonesia (Java, Borneo, Sumatra), China, Tibet, Japan, Bangladesh, Vietnam, Philippines.

Note: This species is recorded for the first time in Nilgiri Biosphere Reserve, Western Ghats.

Subfamily: Hypocalinae

Tribe: Hypocalini

***Hypocala deflorata* (Fabricius, 1794)**

Hypocala deflorata Fabricius, 1794, *Ent. Syst.* 3 (2): 127.

Hypocala moorei Butler, 1892, *Ann. Mag. Nat. Hist.* (6), 10: 21.

Hypocala australiae Butler, 1892, *Ann. Mag. Nat. Hist.* (6), 10: 21.

Material in the collection: 31.iii.2008, 19 ex.; 06.iii.2009, 23 ex.; 13.iv.2009, 29 ex.; 26.iii.2010, 21 ex.; 15.iv.2010, 16 ex.; 03.ix.2010, 23 ex.; 26.iii.2011, 23 ex.; 26.iv.2011, 26 ex.; 07.ix.2011, 27 ex.; 18.iii.2012, 17 ex.; 29.iv.2012, 32 ex.; 29.ix.2012, 4 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Coonoor Municipal building, Sim's Park, Kethi, Emerald Dam, and Kothagiri Pandian Park. Kodaikanal: Moonjikal, Bryant Park, Bear Shola, and Observatory.

Distribution: India, Korea, Japan (Honshu, Shikoku, Kyushi, Tsushima Is., Okinawa Is.), South Russian Far East (migrant), Indonesia (Borneo, Fiji (Rotuma), New Caledonia), Sri Lanka, Nepal, Africa, China, Vanuatu, France, Samoa vagrant to Norfolk Islands, New Zealand, Australia (Queensland), Hawaii.

***Hypocala subsatura* Guenée, 1852**

Hypocala subsatura Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 75.

Hypocala aspersa Butler, 1883, *Proc. zool. Soc. Lond.*, 1883: 164.

Hypocala subsatura var. *limbata* Butler, 1889, *Illust. Typical Specimens lepid. Heterocera Colln Br. Mus.*, 7: 76.

Hypocala subsatura Guenée 1852 Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 35.

Material in the collection: 13.iv.2009, 9 ex.; 15.iv.2010, 6 ex.; 03.ix.2010, 3 ex.; 26.iv.2011, 6 ex.; 07.ix.2011, 7 ex.; 29.iv.2012, 3 ex.; 29.ix.2012, 7 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Coonoor Municipal building, and Sim's Park. Kodaikanal: Bus Terminus and Moonjikal.

Distribution: India, Thailand, Malaysia, Myanmar, Vietnam, Nepal, Pakistan, Indonesia (Borneo, Java), China, Taiwan, Japan, Korea, South of Russian Far East.

***Hypocala guttiventris* (Walker, [1858] 1857)**

Hypocala guttiventris Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 13: 1176.

Hypocala lattivitta Walker, 1865, *List Specimens lepid. Insects Colln Br. Mus.* 33: 929.

Material in the collection: 09.v.2009, 32 ex.; 15.v.2010, 2 ex.; 27.v.2011, 2 ex.; 12.v.2012, 2 ex.

Collection Localities: Nilgiri Biosphere Reserve: Benchmark Tea Museum, Coonoor Municipal building, and Sim's Park. Kodaikanal: Bus Terminus.

Distribution: India, Thailand, Malaysia, Laos, Vietnam, Sri Lanka, Taiwan, Philippines, Indonesia (Sumatra, Borneo, Java, Sulawesi, Timor, Flores), Australia.

***Hypocala rostrata* (Fabricius, 1794)**

Hypocala rostrata Fabricius, 1794, *Ent. Syst.* 3(2): 127.

Hypocala plumicornis Guenée, 1852, *Noct.* iii.

Hypocala efflorescens Guenée, 1852, *Noct.* iii.

Material in the collection: 15.iv.2009, 3 ex.; 09.v.2009, 2 ex.; 10.iv.2010, 7 ex.; 27.v.2010, 7 ex.; 07.vi.2010, 4 ex.; 03.ix.2010, 7 ex.; 26.iv.2011, 3 ex.; 23.v.2011, 11 ex.; 28.vi.2011, 3 ex.; 07.ix.2011, 3 ex.; 29.iv.2012, 5 ex.; 29.v.2012, 6 ex.; 23.vi.2012, 2 ex.; 29.ix.2012, 8 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Coonoor Municipal building, Sim's Park, and Kethi. Kodaikanal: Bus Terminus, Moonjikal, Bryant Park, and Bear Shola.

Distribution: India, Thailand, Indochina, Korea Japan (Shikoku, Kyushu), China, Taiwan, Philippines, Indonesia, Nepal, Pakistan, Afghanistan, Africa.

***Hypocala violacea* Butler, 1879**

Hypocala violacea Butler, 1879, *Trans. Ent. Soc. London* 1879: 6.

Hypocala clarissima Butler, 1892, *Ann. Mag. Nat. Hist.* (6), 10: 21.

Hypocala kebeae Bethune-Baker, 1906, *Novit. zool.* 13: 249.

Hypocala violacea Butler Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 35.

Material in the collection: 31.iii.2008, 13 ex.; 06.iii.2009, 32 ex.; 15.iv.2009, 29 ex.; 26.iii.2010, 29 ex.; 10.iv.2010, 22 ex.; 26.iii.2011, 13 ex.; 26.iv.2011, 31 ex.; 18.iii.2012, 9 ex.; 29.iv.2012, 33 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, Coonoor Municipal building, Kethi, Doddabetta, Ithalar, Emerald Dam and Kothagiri. Kodaikanal: Kodaikanal Lake, Bryant Park, Bear Shola, Coaker's Walk, Moonjikal, Perumalmalai, Poomparai, and Observatory.

Distribution: India, Thailand, Vietnam, Nepal, Indonesia (Timor, Flores, New Guinea), Philippines, Taiwan, Japan (Kyushu), Korea.

***Hypocala biarcuata* Walker, 1858**

Hypocala biarcuata Walker, 1858, *Cat.* xv: 1816; Hampson, 1894, *Faun. Brit. Ind.* ii: 454.

Material in the collection: 31.iii.2008, 9 ex.; 06.iii.2009, 13 ex.; 13.iv.2009, 19 ex.; 26.iii.2010, 19 ex.; 15.iv.2010, 14 ex.; 03.ix.2010, 16 ex.; 26.iii.2011, 13 ex.; 26.iv.2011, 17 ex.; 07.ix.2011, 18 ex.; 18.iii.2012, 17 ex.; 29.iv.2012, 22 ex.; 29.ix.2012, 6 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, Coonoor Municipal building, Kethi, Doddabetta, and Kothagiri Pandian Park. Kodaikanal: Kodaikanal Lake, Bryant Park, Bear Shola, Coaker's Walk, Moonjikal, Perumalmalai, Poomparai, and Observatory.

Distribution: India, Thailand, Malaysia, Taiwan, South Japan, Indonesia (Sulawesi, Sumbawa, New Guinea).

Subfamily: Tinoliinae

Tribe: Tinoliini

***Calesia stillifera* Felder & Rogenhofer, 1874 (= *satellita*)**

Calesia stillifera Felder & Rogenhofer 1874, *Reise ost. Fregatte Novara* 2(2): Pl: 117:18.

Calesia satellita Moore, [1885], *Lepid. Ceylon*, 3: 184, Pl.171: 6.

Material in the collection: 15.iv.2009, 2 ex.; 10.iv.2010, 1 ex.; 26.iv.2011, 1 ex.; 29.iv.2012, 2 ex.

Collection Localities: Nilgiri Biosphere Reserve: Benchmark Tea Museum. Kodaikanal.

Distribution: India, Thailand, Cambodia, Vietnam, Sri Lanka, China, Philippines.

Subfamily: Erebinae

Tribe: Toxocampini

Subtribe: Toxocampina

***Lygephila dorsigera* (Walker, 1865)**

Lygephila dorsigera (Walker, 1865), *List Specimens lepid. Insects Colln Br. Mus.* 33: 873.

Material in the collection: 23.ix.2009, 1 ex.; 03.ix.2010, 2 ex.; 17.ix.2011, 1 ex.; 07.ix.2012, 1 ex.

Collection Localities: Kodaikanal: Moonjikal.

Distribution: India, Thailand, Nepal, Sri Lanka, Pakistan, Afghanistan, Korea, Japan, China, South Russian Far East, Russia (Khabarovsk).

Tribe: Acantholipini

***Hypospila bolinoides* Guenée, 1852**

Hypospila bolinoides Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 358.

Thermesia signipalpis Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 15: 1572.

Hypospila thermesina Guenée, 1863, *in Maillard, Notes sur l'Ile de la Réunion* Lep: 53.

Moepa concisa Walker, 1865, *List Specimens lepid. Insects Colln Br. Mus.* 33: 982.

Thermesia orientalis Leech, 1900, *Trans. Ent. Soc. London* 1900: 570.

Hypospila andamana Swinhoe, 1919, *Ann. Mag. Nat. Hist.* (9) 4: 124.

Hypospila bolinoides Guenée Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 38.

Material in the collection: 15.iv.2009, 2 ex.; 09.v.2009, 3 ex.; 10.iv.2010, 1 ex.; 15.v.2010, 2 ex.; 26.iv.2011, 1 ex.; 2 ex.; 27.v.2011, 3 ex.; 29.iv.2012, 12.v.2012, 2 ex.

Collection Localities: Kodaikanal: Bus Terminus, Bryant Park, Moonjikal, and Bear Shola.

Distribution: India, Thailand, Vietnam, Cambodia, Nepal, Indonesia (New Guinea, Moluccas), Taiwan, China, Japan, Korea, Australia, Caroline Is.

Tribe: Erebini

***Erebus hieroglyphica* (Drury, 1773)**

Noctua hieroglyphica Drury, 1773, *Ill. Exot. Ins.* 2: 3.

Noctua harmonia Cramer, [1777] 1779, *Uitlandsche Kapellen* 2: 119.

Noctua mygdonia Cramer, [1777] 1779, *Uitlandsche Kapellen* 2: 119.

Noctua ulula Fabricius, 1781, *Species Insectorum* 2: 211.

Bocana lunaris Walker, 1864, *List Specimens lepid. Insects Colln Br. Mus.* 29: 57.

Argiva hieroglyphica celebensis Hopffer, 1874, *Stettin. ent. Ztg.* 35: 46.

Nyctipao hieroglyphica tenebrata Prout, 1919, *Ann. Mag. Nat. Hist.* (9)3: 170.

Erebus hieroglyphica Drury Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 29; Kobes, 1985: Heteroc. Sumatr. 26.

Material in the collection: 09.v.2009, 3 ex.; 15.v.2010, 2 ex.; 27.v.2011, 3 ex.; 12.v.2012, 2 ex.

Collection Localities: Kodaikanal: Bryant Park, Moonjikal, Bear Shola, and Senbaganur.

Distribution: India, Thailand, Malaysia, Cambodia, Vietnam, Myanmar, China, Indonesia (Sumatra, Borneo, Java, Sulawesi, New Guinea), Philippines.

***Erebus macrops* (Linnaeus, 1768)**

Noctua macrops Linnaeus, 1768, *Syst. Nat.* 12(3) App.: 225.

Noctua bubo Fabricius, 1781, *Species Insectorum* 2: 209.

Patula boopis Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 178.

Eupatula macrops Linnaeus, Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 29; Kobes, 1985: Heteroc. Sumatr. 27.

Material in the collection: 09.iv.2009, 12 ex.; 09.v.2009, 3 ex.; 15.iv.2010, 6 ex.; 27.v.2010, 4 ex.; 03.ix.2010, 12 ex.; 13.x.2010, 7 ex.; 26.iv.2011, 9 ex.; 07.ix.2011, 6 ex.; 07.x.2011, 8 ex.; 29.iv.2012, 9 ex.; 23.v.2012, 6 ex.; 15.x.2012, 12 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, Coonoor Municipal building, and Kethi. Kodaikanal: Bus Terminus, Moonjikal, Bryant Park, and Bear Shola.

Distribution: India, Thailand, Malaysia, Vietnam, Myanmar, Nepal, Bangladesh, Sri Lanka, China, Indonesia (Sumatra, Java, Borneo), Philippines, Japan, Korea, South of Russian Far East (migrant), Central Africa.

***Lygniodes reducens* Fabricius, 1794**

Material in the collection: 10.iv.2010, 2 ex.; 21.vi.2011, 3 ex.

Collection Localities: Kodaikanal: Bryant Park.

Distribution: India.

Lygniodes hypoleuca* Guenée, 1852

Lygniodes hypoleuca In Boisduval & Guenée, 1852, *Hist. Nat. Insects* (Lepid.) 7: 125, pl. 16.

Material in the collection: 10.iv.2010, 2 ex.; 21.vi.2011, 1 ex.

Collection Localities: Kodaikanal: Bryant Park.

Distribution: India, Thailand, Cambodia, Vietnam, Nepal, Bangladesh, China, Taiwan.

Note: This species is recorded for the first time in Nilgiri Biosphere Reserve, Western Ghats.

***Sympis rufibasis* Guenée, 1852**

Sympis rufibasis Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 344.

Sympis rufibasis Guenée; Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 34.

Remarks: Hampson has described the female as not having the scarlet lunule, but we have seen the marking in the present described species.

Material in the collection: 15.iv.2009, 4 ex.; 10.iv.2010, 3 ex.; 26.iv.2011, 4 ex.; 29.iv.2012, 2 ex.

Collection Localities: Kodaikanal: Bus Terminus, Bryant Park, Moonjikal, and Bear Shola.

Distribution: India, Thailand, Laos, Cambodia, Vietnam, Myanmar, Nepal, Sri Lanka, China, Taiwan, Philippines, Indonesia (Sumatra, Java, Borneo, Bali, Flores, Sumbawa, Sulawesi, Moluccas, Amboina, Solomon Is.), Seram, Australian tropics east to New Guinea, Queensland.

Tribe: Catocalini

***Catocala macula* (Hampson, 1891)**

Audea macula Hampson, 1891, *Illust. typical Specimens lepid. Heterocera Colln Br. Mus.* 8: 84.

Ulothrichopus macula reducta Prout, 1922, *Bull. Hill Mus.* Witley 1: 223.

Ulotrichopus macula Hampson; Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 28; Kobes, 1985: Heteroc. Sumatr. 24.

Material in the collection: 27.iii.2008, 3 ex.; 06.iii.2009, 5 ex.; 09.v.2009, 9 ex.; 26.iii.2010, 4 ex.; 15.iv.2010, 7 ex.; 26.iii.2011, 3 ex.; 26.iv.2011, 8 ex.; 27.v.2011, 11 ex.; 18.iii.2012, 3 ex.; 29.iv.2012, 6 ex.; 23.v.2012, 6 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, Coonoor Municipal building, and Kothagiri Pandian Park. Kodaikanal: Bryant Park, Moonjikal, and Senbaganur.

Distribution: India, Taiwan, Thailand, Vietnam, Nepal, Sri Lanka, China, Japan, Indonesia (Java, Borneo, Sumatra, Timur, Flores, Sulawesi), Philippines.

Tribe: Cocytiini

***Serrodes campana* Guenée, 1852**

Serrodes campana Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 252.

Serrodes nigha Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 253.

Serrodes callipepla Prout, 1929, *Ann. Mag. Nat. Hist.* (10)3: 598.

Serrodes campana Guenée, Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 34.

Material in the collection: 15.iv.2009, 11 ex.; 10.iv.2010, 7 ex.; 07.vi.2010, 9 ex.; 17.xii.2010, 5 ex.; 26.iv.2011, 9 ex.; 28.vi.2011, 6 ex.; 15.xii.2011, 3 ex.; 29.iv.2012, 13 ex.; 23.vi.2012, 12 ex.; 29.xii.2012, 4 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, Coonoor Municipal building, Nonsuch, Kethi, and Bandisolai; Kodaikanal: Moonjikal, Bryant Park, Bear Shola, Senbaganur, and Perumalmalai.

Distribution: India, Thailand, Indochina, Nepal, China, Taiwan, Japan, Korea, Russian Far East (migrant), Vanuatu, Indonesia (New Guinea, Samoa, New Caledonia Fiji), Philippines, Australia.

***Avatha discolor* (Fabricius, 1794)**

Noctua discolor Fabricius, 1794, *Ent. Syst.* III, 2: 50.

Avatha includens Walker, 1857, *List Specimens lepid. Insects Colln Br. Mus.* 13: 1107.

Hypaetra trigonifera Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 14: 1411.

Hypaetra curvifera Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 14: 1412.

Hypaetra complacens Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 14: 1414.

Ophiusa frontalis Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 14: 1434.

Achaea expectans Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 15: 1827.

Avatha discolor Fabricius; Kobes, 1985: Heteroc. Sumatr. 50.

Remarks: This species is often mistaken for a form of *Avatha noctuoides*.

Material in the collection: 15.iv.2009, 2 ex.; 10.iv.2010, 3 ex.; 07.vi.2010, 3 ex.; 03.ix.2010, 4 ex.; 13.x.2010, 3 ex.; 17.xii.2010, 7 ex.; 26.iv.2011, 2 ex.; 28.vi.2011, 2 ex.; 07.ix.2011, 6 ex.; 07.x.2011, 3 ex.; 15.xii.2011, 6 ex.; 29.iv.2012, 3 ex.; 23.vi.2012, 2 ex.; 29.ix.2012, 7 ex.; 15.x.2012, 3 ex.; 29.xii.2012, 3 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, Coonoor Municipal building, and Kethi. Kodaikanal: Moonjikal and Bryant Park.

Distribution: India, Thailand, Laos, Sri Lanka, Taiwan, South Japan, Philippines, Indonesia (Sumatra, New

Caledonia, Tenimber Isl., New Guinea, Vanuatu, Cook Is., Marquesas, Society Isl., Fiji), Australia.

Tribe: Euclidiini

***Trigonodes hyppasia* (Cramer, 1779)**

Noctua hyppasia Cramer, [1779] 1782, *Uitlandsche Kapellen* 3: 99.

Phalaena deliana Stoll, 1790, *Uitlandsche Kapellen* 5: 160.

Ophiusa anfractuosa Boisduval, 1833, *Fauna entomologique de Madagascar, Bourbon et Maurice* Lep: 104.

Trigonodes acutata Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 283.

Trigonodes exportata Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 284.

Trigonodes inacuta Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 284.

Trigonodes compar Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 14: 1451.

Trigonodes hyppasia Cramer; Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 31; Kobes, 1985: Heteroc. Sumatr. 47.

Material in the collection: 11.vi.2008, 2 ex.; 28.vi.2009, 1 ex.; 07.vi.2010, 1 ex.; 21.vi.2011, 1 ex.; 19.vi.2012, 2 ex.

Collection Localities: Kodaikanal: Bus Terminus.

Distribution: India, Thailand, Cambodia, Vietnam, Sri Lanka, Nepal, Pakistan, Iran, China, Taiwan, Japan, Philippines, Indonesia (Sumatra, Borneo, Java, Sumbawa, New Guinea, Tongo, New Caledonia, Vanuatu, Norfolk Is., Tenimber Is.), Australia, Africa, Mauritius, Madagascar, Seychelles.

Subtribe: Mocisiini

***Mocis frugalis* (Fabricius, 1775)**

Noctua frugalis Fabricius, 1775, *Syst. Ent.*: 601.

Chalciope lycopodia Geyer, 1837, *Hübner's Zuträge Samml. exot. Schmett.* 5: 25.

Remigia translata Walker, 1865, *List Specimens lepid. Insects Colln Br. Mus.* 33: 1015.

Remigia nigripunctata Warren, 1913, *Gross-Schmett. Erde* 3: 333.

Mocis frugalis Fabricius; Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 31; Kobes, 1985: Heteroc. Sumatr. 49.

Material in the collection: 07.v.2009, 4 ex.; 27.v.2010, 6 ex.; 03.ix.2010, 5 ex.; 15.xii.2010, 3 ex.; 05.v.2011, 8 ex.; 07.ix.2011, 7 ex.; 12.xii.2011, 6 ex.; 29.ix.2012, 5 ex.; 29.xii.2012, 4 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Doddabetta, Kethi, Sim's Park, Coonoor Municipal building, Nonsuch, and Kothagiri Pandian Park. Kodaikanal: Lake, Bryant Park, Moonjikal, Senbaganur, and Perumalmalai.

Distribution: India, Thailand, Malaysia, Cambodia, Laos, Vietnam, Nepal, Pakistan, Sri Lanka, China, Taiwan, Japan, Philippines, Vanuatu, Indonesia (Sumatra, Java, Sulawesi, New Guinea, Solomon Is., New Caledonia, Samoa, Kermadec Is.), Micronesia, Australia.

***Mocis undata* (Fabricius, 1775)**

Noctua undata Fabricius, 1775, *Syst. Ent.*: 600.

Phalaena archesia Cramer, [1780] 1782, *Uitlandsche Kapellen* 3: 145.

Phalaena virbia Cramer, [1780] 1782, *Uitlandsche Kapellen* 3: 146.

Remigia gregalis Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 320.

Ophisma velata Walker, [1863] 1864, *J. Linn. Soc. (Zool.)* 7: 180.

Remigia bifasciata Walker, 1865, *List Specimens lepid. Insects Colln Br. Mus.* 33: 1014.

Cauninda bifasciata Warren, 1913, *Gross-Schmett. Erde* 3: 333.

Mocis uberia Wileman, 1923, *Entomologist* 56: 190.

Mocis undata Fabricius, Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 31; Kobes, 1985: Heteroc. Sumatr. 48.

Material in the collection: 07.v.2009, 12 ex.; 27.v.2010, 8 ex.; 03.ix.2010, 9 ex.; 15.xii.2010, 6 ex.; 05.v.2011, 13 ex.; 07.ix.2011, 6 ex.; 12.xii.2011, 7 ex.; 29.ix.2012, 11 ex.; 29.xii.2012, 6 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, Coonoor Municipal building, Nonsuch, Bandisolai, Kethi, and Kothagiri Pandian Park. Kodaikanal: Moonjikal, Kodaikanal Lake, Bryant Park, and Bear Shola.

Distribution: India, Thailand, Cambodia, Vietnam, Nepal, Sri Lanka, China, Taiwan, Japan, Korea, South of Russian Far East (migrant), Philippines, Indonesia (Sumatra, Timor, Flores, Sumbawa, Borneo).

Tribe: Ercheiini

***Ercheia cyllaria* (Cramer, 1782)**

Noctua cyllaria Cramer, [1779] 1782, *Uitlandsche Kapellen* 3: 100.

Achaea cyllota Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 248.

Achaea fusifera Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 14: 1398.

Achaea signivitta Walker, 1858, *List Specimens lepid.*

Insects Colln Br. Mus. 14: 1398.

Achaea polychroma Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 14:1400.

Achaea atrivitta Walker, 1864, *J. Linn. Soc. (Zool.)* 7: 181.

Achaea purpureilinea Walker, 1864, *J. Linn. Soc. (Zool.)* 7: 181.

Achaea semipallida Walker, 1864, *J. Linn. Soc. (Zool.)* 7: 181.

Ercheia tenebrosa Moore, 1867, *Proc. zool. Soc. Lond.* 1867: 66.

Melipotis gundiana Felder, 1874, *Reise öst. Fregatte Novara* Lep: pl. 116, f. 10.

Melipotis costipannosa Moore, 1882, *Descr. new Indian lepid. Insects Colln W.S. Atkinson*: 166.

Ercheia pannosa Moore, 1883, *Proc. zool. Soc. Lond.* 1883: 24.

Ercheia uniformis Moore, 1883, *Proc. zool. Soc. Lond.* 1883: 24.

Ercheia anvira Swinhoe, 1918, *Ann. Mag. Nat. Hist.* (9)2: 77.

Ercheia cyllaria Cramer Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 30; Kobes, 1985: Heteroc. Sumatr. 36.

Material in the collection: 15.iv.2008, 3 ex.; 09.iv.2009, 2 ex.; 07.v.2009, 3 ex.; 12.xi.2009, 5 ex.; 03.iv.2010, 4 ex.; 16.iv.2010, 5 ex.; 27.v.2010, 6 ex.; 03.ix.2010, 5 ex.; 07.ix.2010, 7 ex.; 20.xi.2010, 3 ex.; 05.v.2011, 3 ex.; 07.xi.2011, 8 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Ooty Lake, Doddabetta, Sim's Park, Coonoor Municipal building, Nonsuch, and Kothagiri Pandian Park; Kodaikanal: Moonjikal, Bryant Park, Bear Shola, and Senbaganur

Distribution: India, Taiwan, Japan, Indochina, Thailand, Peninsular Malaysia, Indonesia (Sumatra, Borneo, Ceram, Kei Islands).

Tribe: Pandesmini

Pandesma quenavadi Guenée, 1852

Pandesma quenavadi Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 6: 438.

Pandesma jubra Swinhoe, 1889, *Proc. zool. Soc. Lond.*, 1889: 413.

Material in the collection: 15.iv.2009, 7 ex.; 10.iv.2010, 3 ex.; 07.vi.2010, 6 ex.; 03.ix.2010, 11 ex.; 13.x.2010, 13 ex.; 26.iv.2011, 6 ex.; 28.vi.2011, 12 ex.; 07.ix.2011, 13 ex.; 07.x.2011, 5 ex.; 29.iv.2012, 2 ex.; 23.vi.2012, 9 ex.; 29.ix.2012, 8 ex.; 15.x.2012, 8 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, Coonoor Municipal building, and Bandisolai; Kodaikanal: Moonjikal, Bryant Park, Bear Shola, Pallangi, Poomparai, and Senbaganur.

Distribution: India, Taiwan, Burma, Thailand, Japan, Indonesia (Sumatra, Borneo, Java), Philippines, Australia.

Polydesma boarmoides Guenée, 1852

Polydesma boarmoides Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 6: 441.

Polydesma mastrucata Felder & Rogenhofer, 1874, *Reise öst. Fregatte Novara* Lep. 4: pl. 111, f. 31.

Material in the collection: 15.iv.2009, 2 ex.; 10.iv.2010, 3 ex.; 07.vi.2010, 3 ex.; 03.ix.2010, 4 ex.; 13.x.2010, 3 ex.; 26.iv.2011, 4 ex.; 28.vi.2011, 2 ex.; 07.x.2011, 5 ex.; 07.ix.2011, 3 ex.; 29.iv.2012, 2 ex.; 23.vi.2012, 6 ex.; 29.ix.2012, 7 ex.; 15.x.2012, 6 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Sim's Park. Kodaikanal: Bryant Park.

Distribution: India, Thailand, Vietnam, Myanmar, Nepal, China, Taiwan, Japan, Korea (migrant), Philippines, Indonesia (Java, Borneo, New Caledonia, Samoa, Fiji Is.), Vanuatu, Society Is., Nicobar Is., Hawaii, Tahiti, Australia.

Ortopla lindsayi (Hampson, 1891)

Material in the collection: 09.v.2009, 2 ex.; 15.v.2010, 5 ex.; 13.x.2010, 3 ex.; 27.v.2011, 7 ex.; 07.x.2011, 3 ex.; 12.v.2012, 6 ex.; 15.x.2012, 8 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, and Coonoor Municipal building. Kodaikanal: Bryant Park, Coaker's Walk, and Perumalmalai.

Distribution: India (Nilgiris).

Tribe: Hulodini

Lacera noctilio (Fabricius, 1794)

Noctua noctilio Fabricius, 1794, *Ent. Syst. III*, 2: 12.

Lacera capella Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 337.

Material in the collection: 15.iv.2009, 12 ex.; 07.v.2009, 13 ex.; 10.iv.2010, 16 ex.; 27.v.2010, 15 ex.; 07.vi.2010, 12 ex.; 03.ix.2010, 7 ex.; 13.x.2010, 31 ex.; 15.xii.2010, 26 ex.; 26.iv.2011, 24 ex.; 05.v.2011, 13 ex.; 28.vi.2011, 13 ex.; 07.ix.2011, 9 ex.; 07.x.2011, 36 ex.; 12.xii.2011, 22 ex.; 29.iv.2012, 22 ex.; 23.vi.2012, 14 ex.; 29.ix.2012, 17 ex.; 15.x.2012, 27 ex.; 29.xii.2012, 26 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, Coonoor Municipal building, Kethi, Doddabetta, Ithalar, Emerald Dam, and Kothagiri. Kodaikanal: Kodaikanal

Lake, Bryant Park, Bear Shola, Coaker's Walk, Moonjikal, Perumalmalai, Poomparai, and Observatory.

Distribution: India, Thailand, Malaysia, Laos, Vietnam, Sri Lanka, Taiwan, Japan, Indonesia (Timor, Flores, Sumbawa, Sulawesi, New Guinea, New Caledonia Fiji, Tongo, Samoa, Solomon Is.), Vanuata, Micronesia (Guam).

***Hulodes caranea* (Cramer, 1780)**

Phalaena caranea Cramer, [1780] 1782, *Uitlandsche Kapellen* 3: 140.

Hulodes angulata Prout, 1928, *Bull. Hill Mus., Witley* 2: 258.

Hulodes caranea Cramer; Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 33.

Material in the collection: 07.v.2009, 3 ex.; 27.v.2010, 5 ex.; 13.x.2010, 12 ex.; 05.v.2011, 4 ex.; 07.x.2011, 6 ex.; 15.x.2012, 7 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, and Coonoor Municipal building. Kodaikanal: Lake, Bryant Park, Bear Shola, Coaker's Walk, Moonjikal, and Perumalmalai.

Distribution: India, Thailand, Malaysia, Myanmar, Nepal, China, Taiwan, Japan, Indonesia (Sumatra, Borneo, Java, Timor, Flores, Kei Is.), Philippines.

***Ericeia inangulata* (Guenée, 1852)**

Hulodes inangulata Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 210.

Remigia optativa Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 14: 1510.

Remigia optatura Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 15: 1848.

Remigia comitata Walker, 1865, *List Specimens lepid. Insects Colln Br. Mus.* 33: 1018.

Hulodes umbrosa Walker, 1869, *Characters undescribed Lepid. Heterocera*: 91.

Ericeia intextilia Schultze, 1908, *Philippine J. Sci.* 3(A): 32.

Ericeia levuensis Prout, 1929, *Ann. Mag. Nat. Hist.* (10)3: 597.

Ericeia certilinea Prout, 1929, *Bull. Hill Mus., Witley*, 3: 112.

Ericeia intextilia Schultze Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 33.

Material in the collection: 15.iv.2009, 3 ex.; 07.v.2009, 3 ex.; 10.iv.2010, 6 ex.; 27.v.2010, 5 ex.; 07.vi.2010, 2 ex.; 03.ix.2010, 9 ex.; 13.x.2010, 3 ex.; 26.iv.2011, 2 ex.; 05.v.2011, 3 ex.; 28.vi.2011, 3 ex.; 07.ix.2011, 7 ex.; 07.x.2011, 6 ex.; 29.iv.2012, 2 ex.; 23.vi.2012, 4 ex.; 29.ix.2012, 6 ex.; 15.x.2012, 7 ex.

Collection Localities: Nilgiri Biosphere Reserve: Benchmark Tea Museum, Sim's Park, and Coonoor Municipal building. Kodaikanal: Kodaikanal Lake, Bryant Park, Bear Shola, Coaker's Walk, Moonjikal, and Perumalmalai.

Distribution: India, Thailand, Malaysia, Laos, Cambodia, Vietnam, Bangladesh, Sri Lanka, Pakistan, Japan, China, Taiwan, Indonesia, Philippines, Africa south of Sahara, Madagascar, Reunion Is.

***Ericeia eriophora* (Guenée, 1852)**

Hulodes eriophora Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 210.

Ophisma deficiens Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 14: 1383.

Remigia perfidiosa Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 14: 1511.

Hypopyra apicalis Walker, [1863] 1864, *J. Linn. Soc. (Zool.)* 7: 178.

Ericeia eriophora Guenée, Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 33.

Material in the collection: 15.iv.2009, 3 ex.; 10.iv.2010, 2 ex.; 13.x.2010, 3 ex.; 26.iv.2011, 2 ex.; 07.x.2011, 3 ex.; 29.iv.2012, 2 ex.; 15.x.2012, 4 ex.

Collection Localities: Kodaikanal: Bus Terminus.

Distribution: India, Philippines, Indonesia (Sulawesi).

Tribe: Ophiusini Guenée, 1837

***Ophiusa olista* (Swinhoe, 1893)**

Ophiusa olista Swinhoe, 1893, *Ann. Mag. Nat. Hist.* (6) 12: 261.

Material in the collection: 15.iv.2008, 3 ex.; 09.iv.2009, 2 ex.; 07.v.2009, 1 ex.; 03.iv.2010, 2 ex.; 16.iv.2010, 2 ex.; 27.v.2010, 3 ex.; 03.ix.2010, 3 ex.; 07.ix.2010, 2 ex.; 05.v.2011, 1 ex.; 15.xii.2011, 2 ex.; 29.xii.2012, 4 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, Coonoor Municipal building, Bandisolai, Kethi, Kothagiri, and Doddabetta. Kodaikanal: Moonjikal, Bear Shola, Bryant Park, and Senbaganur.

Distribution: India, Korea, Japan (Honshu, Shikoku, Kyushu, Tsushima Is.), China, Taiwan, Philippines, Thailand, Vietnam, Nepal.

***Ophiusa discriminans* (Walker, 1858)**

Ophiodes discriminans Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 14: 1358.

Pseudophia pygospila Snellen, 1880, *Tijdschr. Ent.* 23: 98.

Anua intacta Hampson, 1913, *Cat. Lepid. Phal. Colln Br. Mus.* 12: 437.

Anua discriminans Walker, Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 29.

Material in the collection: 15.iv.2009, 2 ex.; 10.iv.2010, 2 ex.; 26.iv.2011, 1 ex.; 29.iv.2012, 3 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, and Coonoor Municipal building. Kodaikanal: Moonjikal, Bear Shola.

Distribution: India, Thailand, Vietnam, Sri Lanka, Philippines, Indonesia (Sumatra, Sulawesi, Kei Isl., Moluccas, New Guinea, Bismarck Archipelago, New Caledonia), Vanuata, Australia.

Ophiusa trapezium **(Guenée, 1852)**

Ophiodes trapezium Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 231.

Ophisma circumferens Walker, 1865, *List Specimens lepid. Insects Colln Br. Mus.* 33: 956.

Ophisma cognata Walker, 1865, *List Specimens lepid. Insects Colln Br. Mus.* 33: 958.

Ophiodes adusta Moore, 1882, *Descr. new Indian lepid. Insects Colln W.S. Atkinson*: 2: 169.

Minucia prunicolor Moore, [1885] 1884–1887: 160.

Ophiusa kebea Bethune-Baker, 1906, *Novit. Zool.* 13: 255.

Anua trapezium Guenée, Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 29.

Ophiusa trapezium Guenée, Kobes, 1985: Heteroc. Sumatr. 35.

Material in the collection: 15.iv.2009, 2 ex.; 26.iv.2010, 1 ex.; 05.x.2010, 3 ex.; 29.iv.2011, 2 ex.; 07.x.2011, 2 ex.; 08.x.2012, 2 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, and Coonoor Municipal building. Kodaikanal: Moonjikal, Bear Shola.

Distribution: India, Thailand, Laos, Vietnam, Nepal, Bangladesh, Sri Lanka, China, Taiwan, Japan, Philippines, Indonesia (Sumatra, Timor, Flores, New Guinea, Bismark Is., New Caledonia), Australia.

Ophiusa triphaenoides **Walker, 1858**

Ophiodes triphaenoides Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 14: 1358.

Ophiodes cuprea Moore, 1867, *Proc. zool. Soc. Lond.* 1867: 74.

Ophiusa triphaenoides Walker; Kobes, 1985: Heteroc. Sumatr. 36.

Material in the collection: 15.iv.2009, 2 ex.; 17.iv.2010, 2 ex.; 26.v.2010, 4 ex.; 27.v.2011, 1 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, and Coonoor Municipal building. Kodaikanal: Bryant Park.

Distribution: India, China, Taiwan, Thailand, Burma, Indonesia (Sumatra, Borneo), Nepal, Japan, Korea, Philippines.

Ophiusa tirhaca **(Cramer, 1777)**

Ophiusa tirhaca (Cramer, 1777), *Uitlandsche Kapellen* 2: 116, Pl. 172.

Ophiusa tirrhaea (Cramer, 1777) Fabricius, 1781 *Spec. Ins.* 2.

Ophiusa vesta Esper, 1789, *Die Schmett.* 4(2): 445, Pl. 141: 1.

Ophiusa olivacea de Villers, 1789, *Caroli Linnaei Ent., Fauna Suecica* 2: 65.

Ophiusa auricularis Hubner [1803], *Samml. Eur. Schmett.* 3: pl. 6: 321.

Ophiusa tirrhaca: Treitschke, 1826, *Die Schmett. Eur.* 5 (3): 300, *misspelling*.

Ophiusa hottentota Guenee, 1852, in Boisduval & Guenée, *Hist. Nat. Insectes* (Lepid.) 7: 229.

Ophiusa tirhaca Walker, 1858, *List Specimens lepid. Insects Colln. Br. Mus.* 14: 1357.

Material in the collection: 09.v.2009, 3 ex.; 15.v.2010, 2 ex.; 27.v.2011, 3 ex.; 12.v.2012, 2 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden and Benchmark Tea Museum. Kodaikanal: Bryant Park.

Distribution: India, Thailand, Vietnam, Nepal, Indonesia, China, Taiwan, Japan, Korea, Russian Far East (migrant), South Russia, South and Central Europe Turkey, Near East, Africa, Madagascar, Seychelles, Australia.

Thyas coronata **(Fabricius, 1775)**

Noctua coronata Fabricius, 1775, *Syst. Ent.*: 596.

Noctua leonine Fabricius, 1775, *Syst. Ent.*: 596.

Noctua ancilla Fabricius, 1794, *Ent. Syst. III*, 2: 17.

Corycia magica Hübner, 1827, *Zuträge Samml. exot. Schmett.* 3: 32.

Ophiodes ponderosa Mabille, 1879, *Annls Soc. ent. Fr.* (5) 9: 346.

Anua coronata Fabricius, Holloway, 1976: Malayan Nature Soc. & Sabah Foundation. 2.

Ophiusa coronata Fabricius, Kobes, 1985: Heteroc. Sumatr. 36.

Material in the collection: 26.iv.2008, 7 ex.; 06.iv.2009, 11 ex.; 09.v.2009, 4 ex.; 15.iv.2010, 13 ex.;

27.v.2010, 9 ex.; 18.iv.2011, 9 ex.; 23.v.2011, 12 ex.; 26.iv.2012, 7 ex.; 29.v.2012, 9 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, Coonoor Municipal building, Bandisolai, Kethi, Kothagiri, and Doddabetta. Kodaikanal: Moonjikal, Bear Shola, Bryant Park, and Senbaganur.

Distribution: India, Thailand, Malaysia, Vietnam, Myanmar, Nepal, Bangladesh, Sri Lanka, Taiwan, Japan, Indonesia (Sumatra, Borneo, Java, Sulawesi, Irian Java, New Guinea, New Caledonia, Samoa, Fiji), Micronesia (Guam), Gilbert Is., Vanuata, Philippines.

***Artena dotata* (Fabricius, 1794)**

Noctua dotata Fabricius, 1794, *Ent. Syst.* III, 2: 55. *Artena dotata* Fabricius, Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 29.

Material in the collection: 26.iv.2008, 3 ex.; 06.iv.2009, 2 ex.; 09.v.2009, 4 ex.; 15.iv.2010, 7 ex.; 27.v.2010, 7 ex.; 03.ix.2010, 4 ex.; 13.x.2010, 3 ex.; 8.iv.2011, 2 ex.; 23.v.2011, 23 ex.; 07.ix.2011, 2 ex.; 07.x.2011, 2 ex.; 26.iv.2012, 2 ex.; 2.v.2012, 5 ex.; 29.ix.2012, 3 ex.; 15.x.2012, 1 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, Coonoor Municipal building, and Kothagiri Pandian Park. Kodaikanal: Bryant Park and Moonjikal.

Distribution: India, Thailand, Malaysia, Vietnam, Cambodia, Nepal, Pakistan, Sri Lanka, China, Taiwan, Japan, Korea, South of Russian Far East (migrant), Indonesia (Sumatra, Borneo), Philippines.

Tribe: Poaphilini

***Achaea janata* (Linnaeus, 1758)**

Geometra janata Linnaeus, 1758, *Syst. Nat.* (Edn 10) 1: 527.

Noctua melicerta Drury, [1773] 1770, *Illust. Nat. Hist. exot. Insects* 1: 46.

Noctua tigrina Fabricius, 1781, *Species Insectorum* 2: 218. *Noctua cyathina* Macleay, 1826, *Cat. Insects Coll. King* pp. 138–469.

Catocala traversii Fereday, 1877, *Trans. N. Z. Inst.* 9: 457. *Ophiusa ekeikei* Bethune-Baker, 1906, *Novit. Zool.* 13: 256. *Achaea janata* Linnaeus, Kobes, 1985: Heteroc.Sumatr. 39.

Material in the collection: 26.iv.2008, 27 ex.; 06.iv.2009, 19 ex.; 09.v.2009, 24 ex.; 15.iv.2010, 23 ex.; 27.v.2010, 19 ex.; 18.iv.2011, 29 ex.; 23.v.2011, 23 ex.; 26.iv.2012, 27 ex.; 29.v.2012, 39 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, Coonoor Municipal building, Bandisolai, Kethi, Doddabetta, and Kothagiri Pandian Park; Kodaikanal: Moonjikal, Bear Shola, Bryant Park, Mattupatti, and Senbaganur.

Distribution: India, Thailand, Malaysia, Vietnam, Nepal, China, Taiwan, Japan, Korea, Indonesia, Micronesia, Philippines.

***Achaea mezentia* Cramer, 1783**

Material in the collection: 23.iii.2008, 7 ex.; 06.iii.2009, 3 ex.; 09.v.2009, 6 ex.; 23.ix.2009, 3 ex.; 26.iii.2010, 3 ex.; 03.ix.2010, 4 ex.; 26.iii.2011, 2 ex.; 27.v.2011, 7 ex.; 18.iii.2012, 1 ex.; 23.v.2012, 9 ex.; 07.ix.2012, 2 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, and Coonoor Municipal building. Kodaikanal: Bryant Park, Moonjikal, Bear Shola, and Senbaganur.

Distribution: India, Sri Lanka.

***Achaea serva* (Fabricius, 1775)**

Noctua serva Fabricius, 1775, *Syst. Ent.*: 593.

Achaea fasciculipes Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 14: 1400.

Achaea serva fuscosuffusa Gaede (ex Strand, 1914) 1938, *Gross-Schmett. Erde* 11: 480.

Achaea serva Fabricius, Holloway. 1976: Malayan Nature Soc. & Sabah Foundation 30, 1982: Malayan Nature Soc. & E.W. Classey 235; Kobes, 1985: Heteroc. Sumatr. 40.

Material in the collection: 31.iii.2008, 18 ex.; 06.iii.2009, 21 ex.; 09.v.2009, 14 ex.; 26.iii.2010, 19 ex.; 15.iv.2010, 7 ex.; 07.vi.2010, 8 ex.; 03.ix.2010, 17 ex.; 26.iii.2011, 13 ex.; 26.iv.2011, 8 ex.; 27.v.2011, 11 ex.; 28.vi.2011, 21 ex.; 07.ix.2011, 13 ex.; 18.iii.2012, 9 ex.; 29.iv.2012, 13 ex.; 23.v.2012, 7 ex.; 23.vi.2012, 9 ex.; 29.ix.2012, 7 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, Coonoor Municipal building, Bandisolai, Kethi, Doddabetta, and Kothagiri Pandian Park. Kodaikanal: Moonjikal, Bear Shola, Bryant Park, Pallangi, and Senbaganur.

Distribution: India (Andaman Islands), Thailand, Malaysia, Vietnam, Nepal, Yemen, China, Taiwan, Japan, Indonesia (Sumatra, Timor, Flores, Sumbawa, Sulawesi, Samoa, Tongo, New Caledonia, Guam), Vanuata, Philippines, Micronesia, Melanesia, Australia.

***Bastilla crameri* (Moore, [1885])**

Dysgonia crameri Moore, 1885, *Lep. Ceylon* 3: 177.

Phalaena (Noctua) achatina Cramer, [1780] 1782, *Uitlandsche Kapellen* 3: 171.

Dysgonia discalis Moore, 1885, *Lep. Ceylon* 3: 177.

Parallelia crameri Moore; Kobes, 1985: Heteroc. Sumatr. 45.

Material in the collection: 09.v.2009, 1 ex.; 27.v.2010, 2 ex.; 03.ix.2010, 2 ex.; 07.ix.2011, 2 ex.; 23.v.2012, 2 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, and Sim's Park. Kodaikanal: Moonjikal, Bryant Park, and Senbaganur.

Distribution: India, Thailand, Cambodia, Vietnam, Myanmar, Nepal, Pakistan, China, Sri Lanka, Andaman Islands, Indonesia (Sumatra).

***Bastilla joviana* (Stoll, 1782)**

Noctua joviana Stoll, 1782, *Uitlandsche Kapellen* 4: 237.

Noctua sinuata Fabricius, 1781, *Species Insectorum* 2: 507.

Dysgonia jovis Hübner, [1823] 1816, *Verz. bekannter Schmett.* p. 269.

Parallelia curvisecta Prout, 1919, *Ann. Mag. Nat. Hist.* (9), 3: 185.

Parallelia joviana Stoll, Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 30.

Material in the collection: 09.v.2009, 2 ex.; 15.v.2010, 2 ex.; 27.v.2011, 3 ex.; 12.v.2012, 5 ex.

Collection Localities: Kodaikanal: Moonjikal, Bear Shola, Bryant Park, Senbaganur, and Perumalmalai.

Distribution: India, Thailand, Laos, Vietnam, Nepal, Sri Lanka, China, Taiwan, Japan, Philippines, Indonesia (Sumatra, Borneo, Java, Timor, Flores, Sumbawa, Sulawesi, Moluccas, New Guinea, Fiji), Australia.

***Parallelia rigidistria* (Guenée, 1852)**

Parallelia rigidistria (Guenée, 1852), In Boisduval & Guenee, *Hist. Nat. Insects* (Lepid.) *Noct.* 7: 240.

Naxia calefaciens Walker, 1858, *List Specimens lepid. Insects Colln Br. Mus.* 14: 1405.

Parallelia mediifascia Wileman & South, 1920: *Entomologist* 53: 273.

Material in the collection: 17.ix.2008, 4 ex.; 23.ix.2009, 1 ex.; 07.vi.2010, 1 ex.; 03.ix.2010, 2 ex.; 28.vi.2011, 2 ex.; 23.vi.2012, 2 ex.; 07.ix.2012, 2 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, and Kothagiri Pandian Park. Kodaikanal: Moonjikal and Bryant Park.

Distribution: India, Thailand, Malaysia, Cambodia, Vietnam, Bangladesh, Sri Lanka, Taiwan, Philippines, Indonesia (Sumatra, Borneo, Sulawesi, Moluccas, Sunda Is., New Guinea, Solomon Is.).

***Bastilla stuposa* (Fabricius, 1794)**

Material in the collection: 15.iv.2009, 2 ex.; 10.iv.2010, 2 ex.; 07.vi.2010, 3 ex.; 26.iv.2011, 1 ex.; 28.vi.2011, 5 ex.; 29.iv.2012, 3 ex.; 23.vi.2012, 4 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Coonoor Municipal building, Sim's Park, and Kothagiri Pandian Park; Kodaikanal: Kodaikanal Lake, Bear Shola, Bryant Park, Moonjikal, and Senbaganur.

Distribution: India, Korea, Cambodia, China, Indonesia (Sumatra, Timor), Japan (Honshu, Shikoku, Kyushu, Ryukyu Is.), Nepal, Philippines, Russian Far East, Sri Lanka, Taiwan, Vietnam.

***Bastilla absentimacula* (Guenée, 1852)**

Naxia absentimacula Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 255.

Dysgonia absentimacula Guenée, Kobes, 1992: Heteroc. Sumatr. 92.

Material in the collection: 17.ix.2008, 2 ex.; 23.ix.2009, 3 ex.; 03.ix.2010, 4 ex.; 07.ix.2012, 2 ex.

Collection Localities: Kodaikanal: Moonjikal, Bear Shola, Bryant Park, and Senbaganur.

Distribution: India, Thailand, Sri Lanka, Taiwan, Indonesia (New Guinea, Java, Sumatra), Korea.

***Bastilla amygdalis* Moore, [1885]**

Dysgonia amygdalis Moore, [1885] 1884–1887, *Lepid. Ceylon* 3: 551.

Parallelia amygdalis Moore, Kobes, 1985: Heteroc. Sumatr. 93.

Material in the collection: 11.vi.2008, 2 ex.; 28.vi.2009, 3 ex.; 07.vi.2010, 1 ex.; 17.xii.2010, 7 ex.; 21.vi.2011, 3 ex.; 15.xii.2011, 2 ex.; 19.vi.2012, 4 ex.; 29.xii.2012, 4 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, Coonoor Municipal building, and Kothagiri Pandian Park. Kodaikanal: Moonjikal, Bryant Park, Bear Shola, and Senbaganur.

Distribution: India, Taiwan, Thailand, Indonesia (Sumatra, Borneo, Sulawesi), Sri Lanka, Nepal.

***Pindara illibata* (Fabricius, 1775)**

Noctua illibata Fabricius, 1775, *Syst. Ent.*: 592.

Hemeroblemma peropaca Hübner, 1825, *Zuträge Samml. exot. Schmett.* 3: 33.

Ophisma laetabilis Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 241.

Pindara colorata Warren, 1913, *Gross-Schmett. Erde* 3: 328.

Pindara illibata Fabricius; Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 30; Kobes, 1985: Heteroc. Sumatr. 41.

Material in the collection: 09.iv.2009, 12 ex.; 09.v.2009, 1 ex.; 15.iv.2010, 6 ex.; 27.v.2010, 4 ex.; 03.ix.2010, 7 ex.; 26.iv.2011, 3 ex.; 07.ix.2011, 6 ex.; 29.iv.2012, 9 ex.; 23.v.2012, 5 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, Coonoor Municipal building, Bandisolai, Kethi, Doddabetta, and Kothagiri Pandian Park. Kodaikanal: Moonjikal, Bear Shola, Bryant Park, and Senbaganur.

Distribution: India, Thailand, Malaysia, Laos, Cambodia, Vietnam, Nepal, Sri Lanka, Myanmar, China, Taiwan, Japan, Philippines, Indonesia (Sumatra, Borneo, Timor, Flores, Sulawesi, Moluccas, Seram, New Guinea, Biak), Australia.

***Grammodes geometrica* (Fabricius, 1775)**

Noctua geometrica Fabricius, 1775, *Syst. Ent.* p. 599.

Phalaena ammonia Cramer, [1779] 1782, *Uitlandsche Kapellen* 3: 98.

Grammodes bifulvata Warren, 1913, *Gross-Schmett. Erde* 3: 331.

Grammodes orientalis Warren, 1913, *Gross-Schmett. Erde* 3: 331.

Grammodes geometrica Fabricius, Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 31; Kobes, 1985: Heteroc. Sumatr. 46.

Material in the collection: 09.iv.2008, 1 ex.; 15.iv.2009, 2 ex.; 18.iv.2010, 2 ex.; 13.x.2010, 3 ex.; 26.iv.2011, 2 ex.; 07.x.2011, 2 ex.; 29.iv.2012, 2 ex.; 15.x.2012, 3 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Sim's Park, and Kothagiri Pandian Park. Kodaikanal: Moonjikal and Bryant Park.

Distribution: India, Thailand, Laos, Cambodia, Vietnam, Myanmar, Nepal, Pakistan, China, Taiwan, Japan, Philippines, Indonesia (Sumatra, Borneo, Sulawesi), Australia, Africa south of Sahara, Ghana, Madagascar.

***Chalciope mygdon* (Cramer, 1777)**

Noctua mygdon Cramer, [1777] 1779, *Uitlandsche Kapellen* 2: 94.

Noctua triangulum Fabricius, 1787, *Mantissa Insectorum* 2: 145.

Chalciope mygdonias Hübner, 1823 [1816], *Verz. bekannter Schmett.* p. 268.

Chalciope mygdon Cramer, Holloway, 1976: Malayan Nature Soc. & Sabah Foundation 31; Kobes, 1985: Heteroc. Sumatr. 48.

Material in the collection: 11.vi.2008, 2 ex.; 28.vi.2009, 3 ex.; 07.vi.2010, 1 ex.; 21.vi.2011, 3 ex.; 19.vi.2012, 4 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, and Sim's Park; Kodaikanal: Bryant Park, Kodaikanal Lake, and Moonjikal.

Distribution: India, Thailand, Malaysia, Laos, Cambodia, Vietnam, Nepal, Sri Lanka, China, Taiwan, Japan, Philippines, Indonesia (Java, Sumatra, Borneo).

***Oxyodes scrobiculata* (Fabricius, 1775)**

Oxyodes scrobiculata Fabricius, 1775, *Syst. Ent.* 592 (Noctua); *Sp. Ins.* ii: 212; Moore, 1882,

Lep. Cey. iii: 164; Hampson, 1894, *Faun. Brit. Ind.* ii: 546.

Phalaena clytia Cramer, 1779, *Pap. Exot.* IV, pl. 399.

Material in the collection: 26.iii.2008, 43 ex.; 26.iv.2008, 45 ex.; 14.ii.2009, 18 ex.; 17.iii.2009, 32 ex.; 06.iv.2009, 41 ex.; 09.v.2009, 34 ex.; 22.ii.2010, 19 ex.; 05.iii.2010, 22 ex.; 15.iv.2010, 39 ex.; 27.v.2010, 28 ex.; 07.vi.2010, 23 ex.; 03.ix.2010, 32 ex.; 13.x.2010, 64 ex.; 20.xi.2010, 27 ex.; 15.xii.2010, 18 ex.;17.ii.2011, 12 ex.; 8.iv.2011, 29 ex.; 23.v.2011, 23 ex.; 28.vi.2011, 27 ex.; 07.ix.2011, 22 ex.; 07.x.2011, 32 ex.; 07.xi.2011, 22 ex.; 9.xii.2011, 23 ex. 26.iv.2012, 37 ex.; 2.v.2012, 25 ex.; 25.vi.2012, 19 ex.; 29.ix.2012, 37 ex.; 45.x.2012, 37 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Doddabetta, Sim's Park, Coonoor Municipal building, Nonsuch, Kethi, Bandsolai, Kothagiri, Ithalar, and Avalanche. Kodaikanal: Moonjikal, Bryant Park, Bear Shola, Observatory, Villpatti, Poomparai, Pallangi, Mattupatti, and Perumalmalai.

Distribution: India, Thailand, Malaysia, Vietnam, Sri Lanka, Nepal, China, Myanmar, Taiwan, Japan, Korea, Indonesia (Sumatra, Sumbawa, Timor, Flores, New Guinea, New Caledonia, Fiji Is., Samoa), Vanuata, Melanesia, Philippines.

Tribe: Catephiini

***Catephia linteola* Guenée, 1852**

Catephia linteola Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 44.

Catephia pilipes Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 44.

Catephia syba Guenée, 1852, *Hist. Nat. Insectes, Spec. gén. Lépid.* 7: 44.

Catephia ecclesiastica Butler, 1874, *Cistula ent.* 1: 292.

Serrodes leucocelis Mabille, 1879, *Ann. Soc. ent. France (5)*, 9: 330.

Nagia accolytis Hampson, 1926, *Descr. Gen. Spec. Noctuinae Br. Mus.* p. 65.

Nagia hieratica Hampson, 1926, *Descr. Gen. Spec. Noctuinae Br. Mus.* p. 66.

Nagia monastica Hampson, 1926, *Descr. Gen. Spec. Noctuinae Br. Mus.* p. 69.

Nagia magaruna de Joannis, 1932, *Livre Centenaire, Soc. ent. Fr.* p. 432.

Nagia homotima Tams, 1935, *Ins. Samoa* 3 (4): 220.

Nagia pilipes griveaudi Viette, 1968, *Lambillionea* 67: 41.

Material in the collection: 09.v.2009, 3 ex.; 15.v.2010, 1 ex.; 27.v.2011, 2 ex.; 12.v.2012, 3 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, and Ooty Lake. Kodaikanal: Moonjikal, Bryant Park, and Bear Shola.

Distribution: India, East Africa, Madagascar, Australia, Sri Lanka, Myanmar, Borneo, Marshall Islands.

Tribe: Hypopyrini

***Spirama retorta* (Clerck, 1759)**

Spirama retorta Cramer, 1779, *Pap. Exot.* ii: pl. 116; Hampson, 1894, *Faun. Brit. Ind.* I: 553.

Noctua spiralis Fabricius, 1781, *Sp. Ins.* ii: 211.

Speiredonia helicina Hübner, 1818, *Zutr.* iii: 14.

Spirama suffumosa Guenee, 1852, *Noct.* iii : 195.

Spirama triloba Guenee, 1852, *Noct.* iii: 197.

Hypopyra mollis Guenee, 1852, *Noct.* iii: 198.

Spirama remota Felder, 1864, *Sitzb. Akad. wiss. Wien. M.N.Cl.* xl, iii : 43.

Spirama cohaerens Walker, 1858, *Cat.* xiv: 1321.

Spirama simplicior Butler, 1881, *Trans. Ent. Soc.* 198.

Spirama modesta Moore, 1879, *Lep. Atk.* 168.

Spirama rosacea Butler, 1889, *Ill. Het.* vii: 78.

Spirama confusa Butler, 1889, *Ill. Het.* vii: 78.

Spirama indenta Hampson, 1893, *Ill. Het.* viii: 89.

Material in the collection: 27.iii.2008, 8 ex.; 06.iii.2009, 4 ex.; 15.iv.2009, 7 ex.; 26.iii.2010, 7 ex.; 10.iv.2010, 6 ex.; 03.ix.2010, 9 ex.; 26.iii.2011, 6 ex.; 26.iv.2011, 2 ex.; 07.ix.2011, 7 ex.; 18.iii.2012, 5 ex.; 29.iv.2012, 2 ex.; 29.ix.2012, 6 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Ooty Lake, Doddabetta, Sim's Park, Coonoor Municipal building, Nonsuch, and Kothagiri. Kodaikanal: Moonjikal, Bryant Park, Bear Shola, Senbaganur, Vattakanal, and Vellagavi.

Distribution: India, Thailand, Korea, Myanmar, Vietnam, Cambodia, Nepal, Bangladesh, Sri Lanka, Indonesia, China, Taiwan, Japan.

***Spirama helicina* (Hübner, 1831)**

Material in the collection: 15.iv.2009, 9 ex.; 07.v.2009, 6 ex.; 10.iv.2010, 5 ex.; 27.v.2010, 4 ex.; 03.ix.2010, 4 ex.; 26.iv.2011, 4 ex.; 05.v.2011, 7 ex.; 07.ix.2011, 6 ex.; 29.iv.2012, 5 ex.; 29.ix.2012, 7 ex.

Collection Localities: Nilgiri Biosphere Reserve: Ooty Botanical Garden, Benchmark Tea Museum, Ooty Lake, Doddabetta, Sim's Park, Coonoor Municipal building, Nonsuch, and Kothagiri. Kodaikanal: Moonjikal, Bryant Park, Bear Shola, Senbaganur, Vattakanal, Mattupatti, and Vellagavi.

Distribution: India, Thailand, Indochina, Nepal, Indonesia (Java, Sumatra), China, Taiwan, Korea, Japan, South of Russian Far East (migrant).

Hyperlopha crucifera* Walker, 1865

Material in the collection: 28.vi.2011, 2 ex.

Collection Localities: Kodaikanal: Moonjikal.

Distribution: Borneo.

Note: The species is reported from India for the first time.

DISCUSSION

The Erebidae are widely distributed throughout the Tamil Nadu part of the Western Ghats, recorded from 250–2,670 m msl. All the species included in this study were captured at elevations between 1,000–2,670 m msl. Maximum numbers of Erebidae moths were recorded during spring (March to May) and monsoon (October to December) seasons. The family Erebidae is represented by subfamilies Erebinae, Hypocalinae, Calpinae, and Scoliopteryginae. Based on our results, the dominant subfamily of Erebidae is Erebinae, which comprises 45 species from 13 tribes. Tribe Poaphilini was represented by 13 species. Calpinae is the second largest subfamily of Erebidae, representing fruit-sucking and vampire moths of 11 species from 3 tribes. The genus *Eudocima* was represented by seven species.

Among the specimens collected, three species, namely *Phyllodes consobrina* Westwood (Phyllodini), *Lygniodes hypoleuca* Guenée (Erebini), and *Hyperlopha crucifera* Walker (Hypopyrini) were reported for the first time from the state. The most widely distributed species in the study area were *Oxyodes scrobiculata*, *Lacera noctilio*, and *Achaea janata* which were recorded from 18 out of 26 localities.The former was most abundant with 830 specimens which accounted for over 50% of the total specimens captured and was collected throughout the year. Four more species, namely *Hypocala deflorata*, *Lacera noctilio*, *Achaea janata*, and *Hypocala violacea* were also recorded as abundant, with 260, 355, 230, and 211 specimens, respectively.

This paper gives some information about the family Erebidae in the Tamil Nadu part of the Western Ghats. However, through upcoming investigations we expect the list of Indian Erebidae to be expanded by several species, both known and undescribed.

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REVIEWS

1. SHIFTING GROUND: PEOPLE, ANIMALS, AND MOBILITY OF INDIA'S ENVIRONMENTAL HISTORY edited by Mahesh Rangarajan and K. Sivaramakrishnan. 2014. Published by Oxford University Press, New Delhi. Size: 21.5 cm x 13.5 cm. 310 pp. Price: ₹ 875/-. Hardbound.

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The enigmatic title is a precursor to what one should expect in the book. A long introduction by the editors, consisting of 38 pages and 73 references/notes, prepares the reader for the following ten chapters written by eminent social scientists and thinkers. The language is heavy, with complicated sentences and equally complicated views on subjects directly or remotely connected with the environmental history of India. Although the language is not technical, there are many complicated sentences with abstruse thoughts. I could not comprehend the meaning and context of many statements. For example, on page 6, "To understand the ways in which nature was redefined it was essential to step beyond political ecology to look at cultural categories and effective communities as areas of contest." Or another sentence "Well-grounded cultural histories of mega fauna showed a series of complex relationships and representations at work, with changing aesthetics and forms of leisure being crucial in shaping the worldview of dominant groups." (page 7).

Fortunately, the remaining chapters are not as complicated as the Introduction. They range from Kathleen D. Morrison's essay "Conceiving Ecology and Stopping the Clock" which talks about watersheds, reservoir systems, climax vegetation theory, palaeoecology, etc., to a highly interesting essay by Julie E. Hughes "Environmental Status and Wild Boars in Princely India". She deals with the environmental history of wild boar, the areas where they existed in the princely states of Rajasthan, and how wild boar helped to define regional cultures. Puzzling linkage, isn't it? Some other chapters worth mentioning are Divyabhanusinh's "Lions, Cheetahs, and Others in the Mughal Landscape", and Ghazala Shahabuddin's "The 'Tiger Crisis' and the Response". These are more straightforward and easy to understand.

Each chapter has its own references and notes, but a select Bibliography covering 20 pages adds value to the book. If you are interested in serious reading on environmental and quasi-environmental issues, this is the book for you. I have certainly added this book to my personal library.

■ ASAD R. RAHMANI

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2. THE SONG OF THE MAGPIE ROBIN by Zafar Futehally, with Shanthi Chandola and Ashish Chandola. 2014. Published by Rupa Publications India Pvt. Ltd, New Delhi. Size: 21.5 cm x 14 cm. 197 pp. Price: ₹ 500/. Hardbound.

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Zafar Futehally, who died in 2013 at the ripe old age of 93, was an iconic figure among amateur birdwatchers and professional ornithologists of India. He was one of the pioneer conservationists of Independent India, in league with the legendary Sálim Ali, M. Krishnan, Dharmakumarsinhji, and E.P. Gee. Despite his genteel disposition, the soft-spoken Zafar, as he preferred to be called, was a resolute fighter when it was the question of nature protection. Recipient of numerous awards and recognitions, he remained a quintessential birdwatcher, enjoying his daily birding even if he had to see the same bird day after day in his large garden. Anyone who had met him, and I had the privilege of knowing him personally, came back impressed by his knowledge, wit, perseverance, and clear ideas on the question of development and conservation.

Shanthi Chandola and Ashish Chandola have to be congratulated for giving to us the biography of this remarkable man. The cover painting by Carl D'Silva, India's finest wildlife artist, of a Magpie Robin pensively looking at Zafar Futehally straddled on his favourite horse outside his sea-side Kihim house, with the splash of sea waves breaking in the background, is superb. The design and get-up of the book is wonderful, for which the publisher Rupa needs to be congratulated.

Zafar Futehally belonged to an illustrious family, with many achievers in various fields, starting with Badruddin Tyabji who was not only a fine barrister, he later became Chief Justice of the Bombay High Court, and for a short time was President of the Indian National Congress. This large family of Bohra Muslims was basically in business and entrepreneurship. Zafar also followed the family tradition and joined Dynacraft Machine Company as a junior partner, and later became its Joint Managing Director, till he was cheated by a relative and thrown out from the company. Being a thorough gentleman, Zafar has not named his cousin in the book. Much later, he was again cheated when he gave the printing of his much-loved *Newsletter for Birdwatchers* (NLBW) to a young upstart, who soon took it over completely and even stopped communicating with Zafar Futehally.

In the history of Indian ornithology, the name *Newsletter for Birdwatchers* will be written in golden words. No other publication has popularized birdwatching and its documentation as this *Newsletter* has done. From its first cyclostyled issue published in December 1959 from Zafar's Andheri (a suburb of Mumbai) house, the *Newsletter* became essential reading for anyone interested in Indian birds. I have quoted articles from the *Newsletter* in all my books – it has such a mine of information.

The book THE SONG OF THE MAGPIE ROBIN is full of interesting anecdotes of the pulls and pressures of the Executive Committee of BNHS. Zafar Futehally was Honorary Secretary of BNHS for many terms, so he had a ring-side view. I recommend this book to readers of *JBNHS*. Rest assured, you will not be disappointed. Zafar lived such a remarkable and successful life, an envy for many of us, and a delight to read about.

■ ASAD R. RAHMANI

3. GREEN WARS: DISPATCHES FROM A VANISHING WORLD by Bahar Dutt. 2014. Published by HarperCollins Publishers India Ltd. New Delhi. Size: 21.5 cm x 13.5 cm 163 pp. Price: ₹ 299/-. Paperback.

doi: 10.17087/jbnhs/2014/v111i3/82385

This is the book that should be read by decision makers as it shows in simple eminently readable language the trials and tribulations of conservation battles that have been fought, and are being fought to keep India green and healthy. The cover of the book shows the skull of a Wild Buffalo, with long majestic horns, floating in a *jheel*, most likely in Kaziranga National Park of Assam, poignantly depicting its lost battle of survival. But other pictures of Hoolock Gibbon and Sarus Crane on the cover symbolize that all is still not lost.

Bahar Dutt, an indomitable fighter, is clearly proved from the first chapter 'Of Charmers and Hunters'. She inherited this spirit from her journalist mother who was the first woman to report on the Indo-Pak war from the border. One of the two daughters of successful parents (her father was in Air India), like any young girl Bahar has a passion to do something different. Her love for animals, and the cruelty that she saw in the animal trade, made her want to become 'the Mother Teresa of the animal world'.

All 12 chapters tell a different story of her personal struggles: to protect the Chambal river from the sand mining mafia, to save Sarus habitat from an airport that a Chief Minister wants in his village – Safai – knowing full well that it will destroy Sarus breeding areas, or her adventurous trip to Nayamgiri Hills in Odisha where the corporate giant Vedanta wants to mine the hill that is sacred to the Dongriya tribals. Every chapter is a delight to read, thanks to simple eloquent language and also contemporariness. Many of these conservation struggles are still going on. For example, Vedanta is still eyeing the richness buried under the sacred mountains. As far as the Dongriyas are concerned, they can be fixed by throwing a few crumbs to them in the form of Corporate Social Responsibility.

Bahar has gone deep into the murky world of environmental permissions that are given (or fixed?) based on dubious Environmental Impact Assessment (EIA) reports, submitted to the Ministry of Environment and Forests (MoEF) (now carrying the additional appellation of Climate Change, so it is now MoEF & CC). Some say that the real meaning of CC is 'corporate clearances'!

Do not get fooled by the sylvan pictures of Goa, sandy beaches, smiling tourists, palm-covered holiday resorts, and gaudily-lit ships offering gambling offshore, therefore technically outside the purview of prevailing laws against gambling that are applicable on land. The twisting of the law is not only for gambling – the real underbelly of crime in Goa is mining. In the chapter "An Encounter with the Mining Mafia of Goa", Bahar describes how she and her party escaped goons set up by the miners when she went there to film the ravages brought about by unrestricted mining of coal in the middle of farmlands.

At the price of only Rs. 299/- it is worth a purchase by anyone interested in conservation. The cover design, get up and overall feel of the book is good, for which the credit should go to the publisher, HarperCollins. I highly recommend this book to everyone.

■ ASAD R. RAHMANI

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MISCELLANEOUS NOTES

1. HANUMAN LANGUR *SEMNOPITHECUS DUSSUMIERI* FEEDING ON THE APICAL STEM OF *EUPHORBIA NIVULIA* AT MOUNT ABU AND KUMBHALGARH WILDLIFE SANCTUARIES IN RAJASTHAN, INDIA

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Hanuman Langur *Semnopithecus dussumieri* is one of the most widely distributed primates of India (Chhangani 2002; Mathur and Manohar 1994; Nag *et al.* 2011; Roonwal *et al.* 1984; Sharma 2010). On September 04, 2005, while surveying the biodiversity of Mount Abu Wildlife Sanctuary in Sirohi district of Rajasthan, we came across a group of Hanuman Langur near Trevor's Tank, feeding on bushes of *Euphorbia nivulia* at about 14:00 hrs. Some in the troop were sitting on a rock holding tender apical tips of the branches of the plant in their hands, while others were climbing up the bushes to pluck the tender stems. The leaves and spines were removed before the stem was eaten, beginning with the lower end. At times, the foraging was so severe that a substantial number of branches on a bush lacked tips. Once the apical tip was lost, the affected branch produced lateral branches during the next monsoon, which too were devoured by the langurs as they had more soft tissue.

Bushes of *E. nivulia* with broken tips can be seen in many parts of Mt Abu and Kumbhalgarh Wildlife Sanctuaries in Rajasthan. *E. nivulia* (Family Euphorbiaceae) is a dendroid, bushy, succulent. It is a xerophytic shrub growing in rocky and dry conditions in many parts of Rajasthan. Every year, during monsoon (pers. obs.), the old bare branches of *E. nivulia* add 2 to 9 inches of new stem. Only the new stem bears leaves, while the old stem remains leafless. After the monsoon, the leaves drop off, leaving behind scars and axillary flower buds, which develop into flowers and fruits during summer. The new stem remains soft till the end of the monsoon. After the departure of the monsoon, the stem hardens and no further feeding by the langurs was observed.

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2. FIRST RECORD OF HODGSON'S BAT *MYOTIS FORMOSUS* HODGSON, 1835 (CHIROPTERA: VESPERTILIONIDAE, MYOTINAE) FROM THE WESTERN GHATS, INDIA

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Hodgson's Bat *Myotis formosus* Hodgson, 1835 (Order: Chiroptera, Family: Vespertilionidae, Subfamily: Myotinae) is a widespread species with its distribution ranging from Afghanistan to North India, Nepal, Tibet, East and Southeast China, Taiwan, Korea, Japan (Tsushima Island) and parts of Southeast Asia (Malaysia, Philippines, Indonesia, Laos) (Smith and Xie 2008; Wilson and Reeder 2005). In the Indian subcontinent, it is known from 19 localities (Molur *et al.* 2002) including the type locality, Kathmandu Valley, Nepal. Of the 19 localities, 15 lie in 10 states in north, east and central India (Bates and Harrison 1997; Fig. 1). Based on the recorded localities, this species mainly appears to be a temperate species with only a few published records from the tropics (Bates and Harrison 1997; Francis 2008; Molur *et al.* 2002). Despite its widespread distribution, it is a poorly known species (Bates and Harrison 1997). The striking pelage and wing colour of *Myotis formosus* are similar to those of the Painted Woolly Bat *Kerivoula picta* Pallas, 1767, which could be a reason for overlooking it, and resulting in its poor documentation. The pelage colour is known to serve the same function in both the species, that of concealment in their diurnal roosts in dry foliage (Menon 2003; Prater 1971). In Taiwan, its roosting site includes the Longan tree *Dimocarpus longan* and in China it was found in an unidentified bush (Bates and Harrison 1997). *M. formosus* is categorized as a Least Concern species by the IUCN, however, it is classified as Near Threatened in Nepal (Molur *et al.* 2002).

On January 12, 2013, at 11:13 hrs, we visited Mullayanagiri peak (13° 23′ 26.47″ N, 75° 43′ 17.56″ E; elevation 1,875 m) in Chikkamagaluru district, Karnataka. Two bats roosting in torpid condition were observed in one of the caves. The cave is at the edge of the Mullayanagiri peak, which has high altitude grasslands interspersed with shola forests. The bats were roosting *c.* 10 m from the mouth of

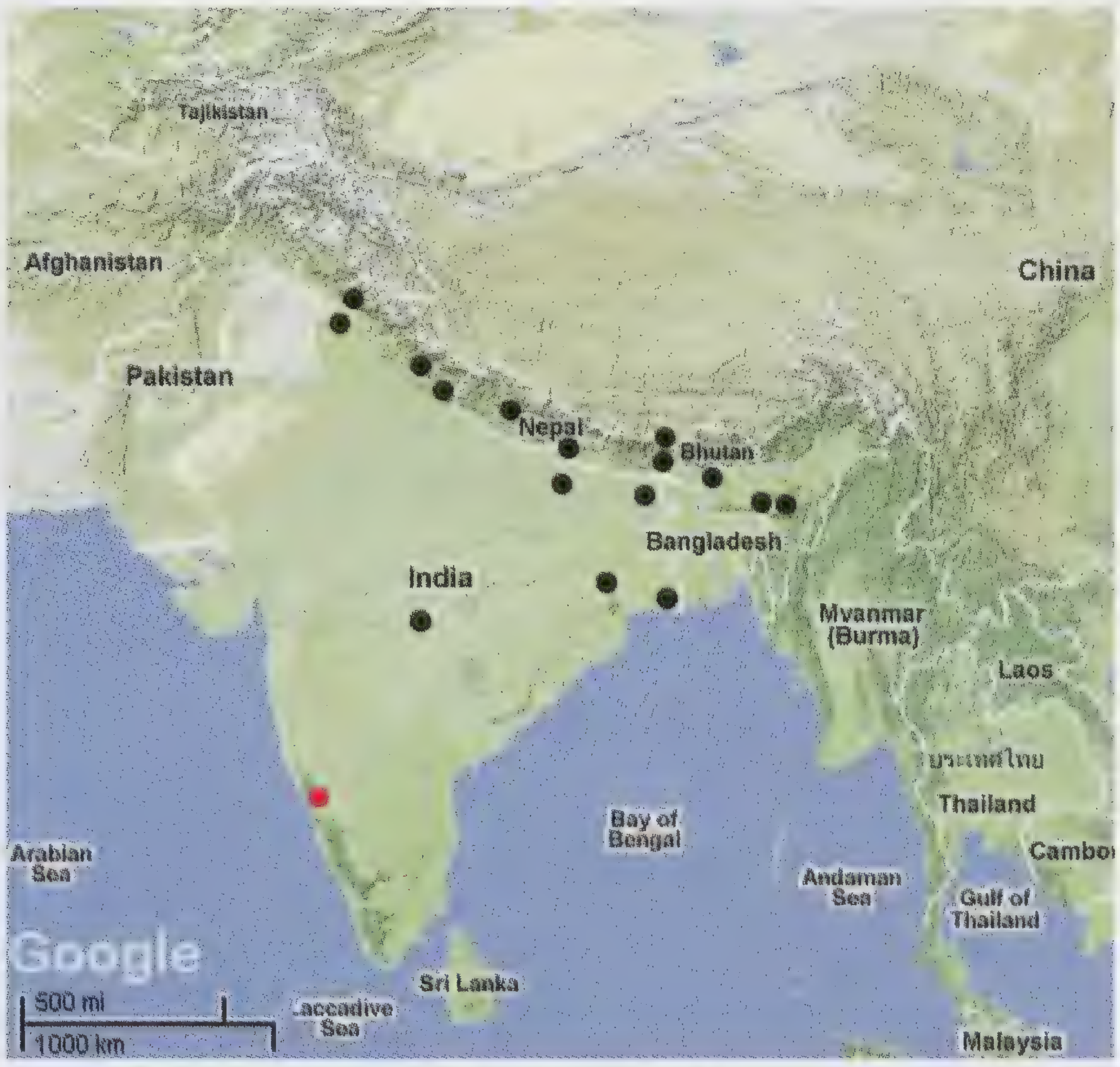

Fig. 1: Published sight records of *Myotis formosus*; new sight records are marked in red

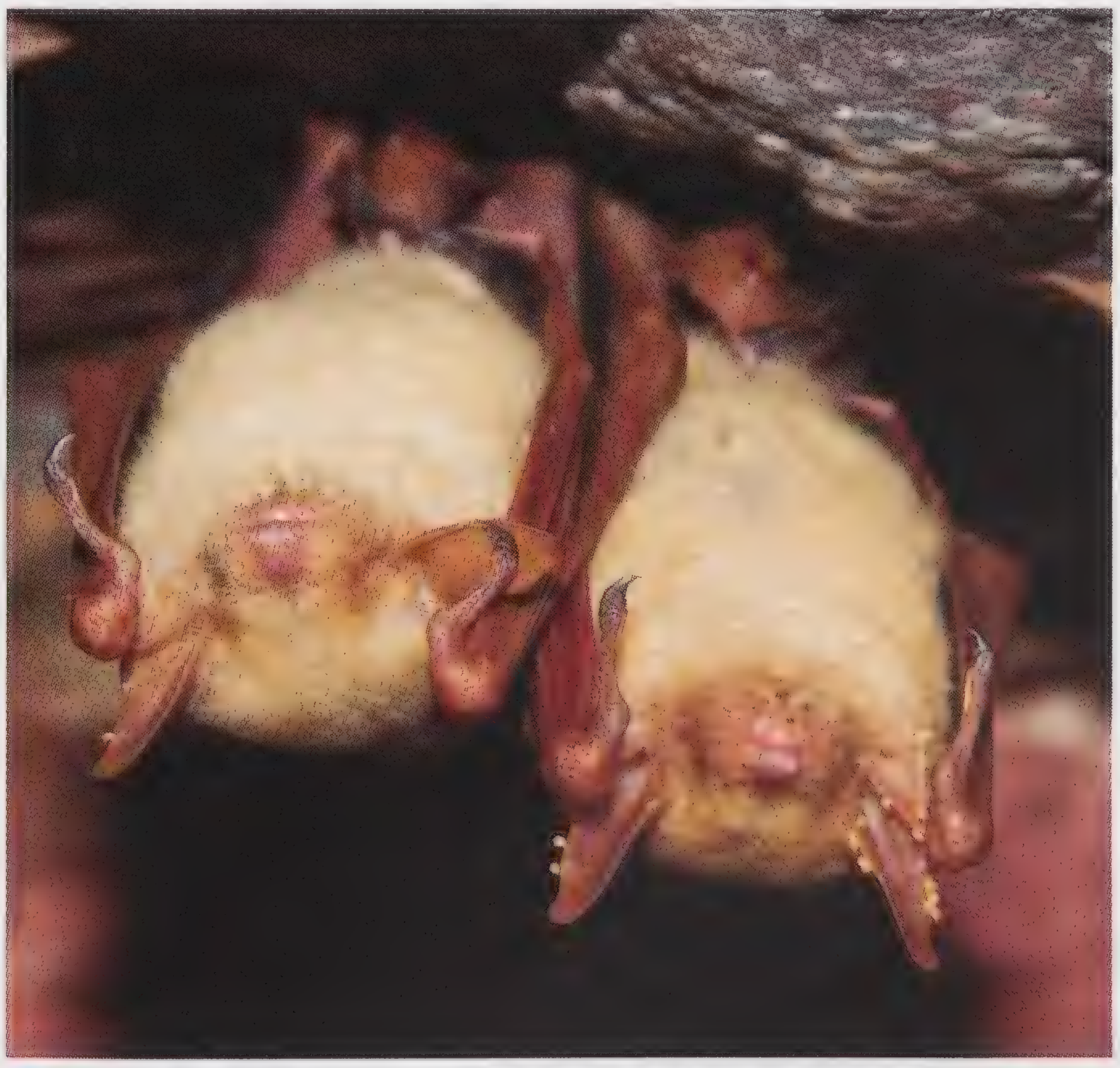

Fig. 2: Ventral view of hibernating *Myotis formosus* from Chikkamagaluru.The shape of the ears and particoloured wings can be seen

the cave and the ceiling was 1.6 m high. Since the bats were torpid, we abstained from catching them. A thorough visual examination was made and the individuals photographed (Fig. 2). Pelage colour was pale buff and the wings and ears were orange. Bold, black markings extending till the femur were visible on the contrasting orange of the wing membranes. The ears were ovate and rounded anteriorly, unlike the funnel-shaped ears of *Kerivoula picta*, and the tragus was long, narrow and pointed. Rough measurements of forearm (FA) and head-body length (HBL) were taken by placing a ruler next to one of the bats, which are FA=47 mm and HBL=70 mm. The morphological characters, combined with our rough measurements, helped confirm our identification.

In India, the southernmost locality of *M. formosus* recorded hitherto was Nagpur in Central India by D'Abreu in 1925 (Bates and Harrison 1997; Molur *et al*. 2002). Menon (2003) has called it a "rare bat" in India, and Bates and Harrison (1997) have suggested that it is a little known bat throughout its geographical range. Our observation is not only significant in that it is the first record of the species from the Western Ghats (at a location *c*. 1,178 km from Nagpur), but is also possibly the first observation of this bat undergoing torpidity in a cave in tropical India. Interestingly, Smith and Xie (2008) have mentioned that in China this bat hibernates in caves, which is also true for many other foliage-roosting bats in the temperate regions of the New World, as cave temperatures are more constant compared to foliage or tree hollows (Altringham 2011).

Specimens of this bat have been collected from altitudes of 1,200–3,000 m in Western Himalaya and Nepal (Bates and Harrison 1997), suggesting that it is not uncommon at high elevations. It is probable that, owing to lack of sampling effort, the species' behaviour of roosting amidst foliage, and misidentification with *Kerivoula picta*, its distribution has remained relatively unknown. We were able to spot this bat perhaps because it was easier to detect, being torpid in a cave. We therefore suggest that the species may well be present in suitable regions of the Western Ghats and in southern India. Night sampling with mist-nets, harp traps, and acoustic sampling may yield more information on its actual status and distribution.

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3. ENDANGERED GANGES RIVER DOLPHIN *PLATANISTA GANGETICA GANGETICA* SIGHTED IN RAPTI RIVER, BALRAMPUR DISTRICT, UTTAR PRADESH, INDIA

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The Ganges River Dolphin *Platanista gangetica gangetica*, also known as *Susu*, was formerly distributed throughout the Ganges-Brahmaputra river system of Bangladesh, India, and Nepal, and possibly Bhutan, below an elevation of *c*. 250 m (Smith *et al*. 2012). Although it still has a fairly extensive range, its distribution has contracted, and its abundance has declined dramatically in some areas. Currently, it is found in the Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu river systems of Bangladesh and India (Smith *et al*. 2012). A few individuals survive in Nepal in the Karnali river, and possibly, the Saptakoshi river (Sinha and Sharma 2003; Smith *et al*. 2012).

Once present in tens of thousands, the Ganges River Dolphin has dwindled abysmally to less than 2,000 during the last century, owing to direct killing, habitat fragmentation by dams and barrages, indiscriminate fishing and pollution of the rivers, mining for sand and stones, and incidental catches in gillnets (Smith *et al.* 2000). Due to decline in population in most of its distribution ranges, it has been given high level of legal protection by declaring it Endangered, and placing it under Schedule I of the Indian Wildlife (Protection) Act, 1972. The species was declared as the National Aquatic Animal of India in 2010 (MoEF 2010).

In Uttar Pradesh, the Ganges River Dolphin is patchily distributed in some rivers with an estimated total population of 671 individuals (Behera *et al.* 2013; WWF-India 2012). Bashir *et al.* (2010) reported a density of 4.97± 0.60 individuals/sq. km in a 28 km stretch of Upper Ganges river between Narora Barrage and Anupshahr. In the Terai Arc landscape, the species is found in and around Dudhwa Tiger Reserve with a population of *c*. 50 individuals in Gerwa river of Katerniaghat WLS, Bahraich district (WWF-India 2012). Little is known about its status from the eastern terai districts of Shravasti, Balrampur, Siddharthnagar, Gorakhpur, and Maharajganj. In December 2009, an individual was sighted in a tertiary canal near Bhinga town in Shravasti district by the second author.

Balrampur district is situated on the banks of the Rapti river. The district shares its north and northeast border with Nepal and is rich in biodiveristy due to its geographic location. Suhelwa Wildlife Sanctuary is situated on the northern boundary of the district. It is a narrow strip (3–7 km wide) of bhabar-terai forest spread in Shravasti and Balrampur districts. The area primarily comprises rugged mountains and boulder strewn river beds, especially along the northern boundary. The Rapti river is part of the Ganges (now Ganga) river system and passes by the city of Balrampur. A biological assessment and human wildlife conflict survey was carried out in Suhelwa WLS by WWF in 2014, during which we obtained sightings of the Ganges River Dolphin in the river near Abar village (27°24′ 43.1″ N; 82°21′ 10.1″ E) and around Suhelwa WLS in December 2014. The first sightings were for a few minutes at a site in the Rapti river at 02:57 hrs on December 31, 2014. Within 30 minutes of the observation, we also recorded about 3 or 4 surface jumps by them.

According to boatmen, there are four Ganges River Dolphins in the 20 km stretch of the river since the last two to three years. Interviews with locals, Forest Department officials and naturalists revealed that the species did not occur there earlier. The probable reason for the sudden presence of these dolphins in the area could have been the result of heavy flooding during the monsoon, which permitted the animals to move in from the bordering areas of Nepal. The incidents of such movements have been reported in several other rivers (Behera *et al.* 2013). As for the conservation issues related to the river, in addition to the Tulsipur and Balrampur sugar mills, a number of drainage outlets from adjoining villages discharge sewage directly into the river. The natural flow of the river has been altered on several occasions and a few villages got submerged after the construction of a dyke. The habitat around the sighting area included agriculture, mainly sugarcane and seasonal crops.

The record of the Ganges River Dolphin, hitherto unknown in the Rapti river, is interesting, and there could possibly be more individuals occurring in the district. There is a need to carry out an intensive survey to assess the status and distribution of the species in Rapti river, and urgent conservation initiatives for the species should be taken up by the Forest Deparment and local NGOs.

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4. A SCIENTOMETRIC ANALYSIS OF THE TRENDS OF INFORMATION DISSEMINATION ON 'TRUE ALBINO' AND 'WHITE' MAMMALS

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Introduction

Four distinct trends were noticed in the mechanism of information dissemination during the last 128 years between 1886 and 2014: (1) Disagreement, confusion or supplementary discussions over the observation or the issue of 'true albino' and 'white variants' have remained alive. (2) The first source of information from the wilderness is no longer confined to professional 'foresters' or the range of biological and nature researchers. It also encompasses a wide spectrum of well-equipped photographers and nature observers. (3) Newspapers and journals with more frequent publication over the internet seem to be preferred because of quick information dissemination. Other parallel outlets used for data dissemination are websites about locations and personal blogs. (4) Information from captive facilities and zoos continues to bear interest for reporting. For an impactful contribution in the field of wildlife data storage and mining, the future is expected from entities having frequently published journals that disseminate searchable soft versions on the internet and reach remote points through hardcopy versions as well.

Background and Results

The present article is an incidental by-product of a search I made for published information on 'albino' Chital *Axis axis*. The search was in connection with the sighting and video-recording of an albino Chital fawn on June 5, 2014, in Satkosia Tiger Reserve (Pradhan *et al.* 2014).

Three primary sources were searched for the required information. The first choice was the *Journal of the Bombay Natural History Society*, covering 128 years from the first issue published in January 1886 to a recent issue of August 2013. It includes 110 volumes with three to four issues per volume. The second choice was publications from Zoo Outreach Organisation (ZOO), Coimbatore. The publications of ZOO that were searched are *Zoos' Print Magazine, Zoos' Print Journal* and *Journal of Threatened Taxa*. The third option, other sources of information, were from the web through Google searches. The journals which were expected to have some information were *Indian Forester*, *Cheetal* magazine of the Wildlife Preservation Society of India, and *Tiger Paper*. A chronological record of information on 'albino' and 'white' mammals that emerged from the exercise is presented in Table 1.

Discussion

The sighting of albino, white or differently coloured animals in nature is rare. Therefore, any new observation, or notes and photographs that are already published on the topic are of considerable interest. When an albino or white animal is born or acquired in captivity, it attracts much attention.

Albino Mammal data frequency

Spread across the 19th to 21st centuries, the *Journal of the Bombay Natural History Society* (*JBNHS*) is the oldest and most appropriate destination for publishing and searching information on natural history from the South Asian region. It provided me with 34 records on the subject of 'white' and 'albino' mammals during 109 years between 1886 and 1994, which is a report frequency of 0.312 instances per year. During the next 15 years from 2000 to 2014, with a frequency of 1.3 instances per year, there are twenty reports in all. These reports include three from *JBNHS*, seven from the Zoo Outreach Organisation, Coimbatore (ZOO), one from the Zoological Survey of India (ZSI), and nine reports in other more recent outlets for information dissemination which are newspapers, websites and personal blogs (Table 1).

Information Dissemination: The Time Factor

It appears that a journal like *Zoos' Print* with monthly publication in hard copy along with soft copy available on the internet is getting preference for quick information dissemination. Two reports from Mahabal *et al.* (2005, 2012) constitute a case on the transitional phase of this aspect.

Table 1: Records of 'true albino' and 'white' mammals accessed

Year of report	Species	Notes on location	Journal / Source	Author and Year
1886	white squirrel, albino birds	Cutch region	*JBNHS*	Newnham (1886)
1886	common mongoose and desert fox with white tail tips	Cutch region	*JBNHS*	Aitken (1886)
1906	albino blackbuck with photo	from Raja of Faridkote for Lahore Zoological Garden	*JBNHS*	Robertson Milne (1906)
1906	white muntjac	caught from north Nepal	*JBNHS*	Smith (1906)
1907	white muntjac	sighted in south India	*JBNHS*	Charrington (1907)
1910	white tiger	Mulin Subdivision, Dhenkanal district, Orissa	*JBNHS*	Editors (1910)
1916	albino hog deer	Cooch Bihar district, West Bengal	*JBNHS*	Adamson (1916)
1916	white tiger	Bilaspur, Central Provinces	*JBNHS*	D'Abreu (1916)
1918	white elephant	calf in Burma, grew darker	*JBNHS*	MacNaghten (1918)
1927	albino elephant	birth in north Siam; identification confirmed by official from Royal White Elephant Department, Bangkok	*JBNHS*	Macfie (1927)
1928	goral	Chamba state	*JBNHS*	Singh (1928)
1928	white tiger (not albino)	shot in Orissa; notes from Editors	*JBNHS*	Robinson (1928)
1932	albino chital	perhaps shot in Dehra Dun	*JBNHS*	Atkinson (1932)
1933	white bison	south Coimbatore jungles	*JBNHS*	Morris (1933)
1933	white bison	more discussion on how the colour should be described	*JBNHS*	Dunbar Brander *et al.* (1933)
1934	white bison	account on white bison	*JBNHS*	Morris (1934)
1935	white bison	discussion regarding white bison	*JBNHS*	Dunbar Brander (1935)
1936	white bison	white bison in Mandla-Balaghat and Chanda district in Central Province	*JBNHS*	Dunbar Brander (1936)
1939	albino sambar	Kohtri Valley, Nainital region	*JBNHS*	Champion (1939)
1946	albino mammals	albinism reports: not uncommon among deer and antelopes; rare in larger mammals; albino tigers, bison and elephants occasional	*JBNHS*	Editors (1946)
1946	albino elephant	Travancore, Kerala 1945	*JBNHS*	Simon (1946)
1946	albino boar	45 miles from Udaipur	*JBNHS*	Sinha (1946)
1949	albino and melanic rat	Rangoon	*JBNHS*	Romer (1949)
1950	albino and melanic rat	Rangoon	*JBNHS*	Harrison (1950)
1951	albino feral rat	Singapore	*JBNHS*	Gibson-Hill (1950)
1953	albino sambar	white sambar stag and hind from two separate reports in Talamalai, north Coimbatore	*JBNHS*	Pillay (1953)
1956	albino elephant	Burma	*JBNHS*	Yin (1956)
1959	albino muntjac	gives list of mammals with partial or complete albinism	*JBNHS*	Editors (1959)
1959	tiger	an account of albinism and partial albinism with reference to Rewa	*JBNHS*	Gee (1959)
1986	albino/white form	birds and mammals in Ahmedabad Zoo	*Zoos' Print Journal*	Anonymous (1986)
1987	nilgai	Sariska; off-white with marking on head	*JBNHS*	Ranjitsinh (1987)
1988	albino bat	*Rhinopoma microphyllum kinnear* in Jodhpur	*JBNHS*	Bhati (1988)
1988	albino sloth bear	female + 3 albino cubs; vill. Madakote, Marwahi, Bilaspur. 1980: a white male seen	*JBNHS*	Bharos (1988)
1994	albino mongoose	15 km from Udaipur	*JBNHS*	Tehsin and Chawra (1994)
2000	albino 'deer' (chital?)	seizure contained two albino deer (chital?) among others	*Newspaper*	Dey (2000) Indian Express

Table 1: Records of 'true albino' and 'white' mammals accessed (*contd.*)

Year of report	Species	Notes on location	Journal / Source	Author and Year
2004	albino palm civet	Phulwari WLSanctuary, Udaipur district	*Zoos' Print Journal*	Sharma (2004)
2004	albino northern palm squirrel	Udaipur	*Zoos' Print Journal*	Sharma (2004)
2004	albino hoary-bellied Himalayan squirrel	Albino female at Samsing in Darjeeling district, West Bengal	*Records of ZSI*	Bhattacharyya and Murmu (2004). (Cited in Kalita, 2009)
2005	albino five-striped palm squirrel	Sindhudurg, Maharshtra	*JBNHS*	Mahabal *et al.* (2012)
2006	albino sambar	Udaipur	*JBNHS*	Tehsin (2006)
2008	white chital	Nagarhole	*Newspaper*	Staff Reporter, Hindu (2008)
2009	albino hoary-bellied squirrel	Sibsagar District, Assam	*JoTT*	Kalita (2009)
2010	albino sambar	Corbett	*JBNHS*	Pande *et al.* (2010)
2010	white sambar	birth at Manipur Zoological Garden	*Newspaper*	Sangai Express (2010)
2010	albino chital	Ahmedabad Zoo	*Newspaper*	Anonymous (2010)
2012	albino bonnet macaque	Goa	*Zoos' Print*	Mahabal *et al.* (2012)
2012	albino sambar	Udaipur	*Newspaper*	Tehsin (2012)
2013	albino chital	albino mother and fawn photograph, Ranthambhore TR	*Zoos' Print*	Prabu *et al.* (2013)
2013	white (albino) porcupine	Nandankanan Biological Park, Odisha	*Website*	Anonymous (2013)
2014	albino blackbuck	Jamshedpur Zoo	*Zoos' Print*	Mohan (2014)
2014	albino chital	with photo, Satkosia Tiger Reserve	*Zoos' Print*	Pradhan *et al.* (2014)
2014	albino chital	Katerniyaghat	*Blog*	Dasgupta (2014)
2014	albino chital	Katerniyaghat	*Blog*	Mishra (2014)
2014	albino chital	Sonanadi WL Sanctuary	*Website*	Anonymous (undated web)

Key: JBNHS- *Journal of the Bombay Natural History Society*, JoTT- *Journal of Threatened Taxa*

Note: Scientific name of species, even if cited in original publication, is excluded as the names may have changed.

The common name of species is according to Prater (1971), and name of mammal-group (eg., mongoose, fox, etc.) and locations are as cited in the publication.

Agoramoorthy (2008) rightly pointed out that some of the journals in India take more than two years for publishing a paper after submission, and as a result, the information becomes outdated. The category of science dealt and disseminated under wildlife is aimed at a targeted audience (Singh 2011), and therefore specialist wildlife journals providing such coverage do not have any or appreciable impact factor (Gunasekaran and Arunachalam 2012).

Changing sources of wildlife data

The higher frequency of publications during 2004–2014 appears to be the result of an increase in the number of people who are writing or reporting back from nature. The first source of information from the wilderness is no longer confined to wildlife professionals comprising 'foresters' or the range of biological and nature researchers. A wide spectrum of well-equipped photographers and nature observers are also making valuable contributions in providing initial and incidental records of an event or feature related to wildlife. Information on blogs and other websites, where a specific description of the animal or a photograph is required, is still significant enough to stimulate further investigation and confirmation.

Information on Captive Animals

Information from captive facilities and zoos continues to interest reporters (Table 1). In 1981, I had the opportunity to meet Dr Reuben David, the founder of Ahmedabad Zoo, when I took trainees from Central Crocodile Breeding and Management Training Institute to observe his collection of 'white' and 'albino' animals. Perhaps, Ahmedabad Zoo holds a record for the maximum number of species in 'white' or 'albino' form held in captivity. The species included in the list are spotted deer, squirrel, rhesus macaque, mongoose, porcupine, crow, sparrow and partridge (Anonymous 1986, 2010). Almost all Zoological Parks have such collections of white and albino animals (Anonymous 2013; Sangai Express 2010), and information appears to hit the newspapers first and then the pages of a scientific journal, if that ever happens.

Lesson for the future

It is felt that in future for permanent and verifiable nature-related information, a researcher would prefer the domains of frequently published journals disseminating searchable soft versions on the internet and making their contents available in remote areas through hard copy versions as well. Such publications, therefore, have a greater role to play in future towards quick publication and dissemination of education and research materials.

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5. SIGHTING OF INDIAN SPOTTED EAGLE *CLANGA HASTATA* FROM TAL CHHAPAR SANCTUARY, RAJASTHAN, INDIA

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On January 26, 2014, we were conducting a bird survey in the Tal Chhapar Wildlife Sanctuary, Rajasthan, an Important Bird Area (now Important Bird and Biodiversity Area), as the site regularly holds a significant number of globally threatened species (Islam and Rahmani 2004). During the visit, we sighted the White-browed Bushchat *Saxicola macrorhynchus*, Water Pipit *Anthus spinoletta*, Common Starling *Sturnus vulgaris*, Isabelline Shrike *Lanius isabellinus*, Green Sandpiper *Tringa ochropus* and Pied Avocet *Recurvirostra avosetta*, among others. But one raptor flying above us caught our eye. It was a medium sized *Clanga* eagle, smaller than the Greater Spotted Eagle *Clanga clanga*, which is a common winter visitor to Rajasthan. The bird had six-fingered primaries, while the Greater Spotted Eagle has seven. PP suggested that this could be the Indian Spotted Eagle *Clanga hastata*. A photograph was taken and later compared with field guides to confirm its identity. Dr. Vibhu Prakash, a well-known raptor expert, confirmed that it was the Indian Spotted Eagle.

The photographed bird matched the description by Naoroji (2007) – a medium sized, well-proportioned eagle, less bulky, clearly smaller and narrower-winged than the

Greater Spotted Eagle. It was found that the bird was an immature, as it had a mottled appearance.

This is the first sight record of the Indian Spotted Eagle from this site. Rasmussen and Anderton (2012) did not record it from most of Rajasthan. Grimmett *et al*. (2011) provided one uncertain record from Rajasthan; Sharma and Singh (1989) did not record this bird from Tal Chhapar. Prakash (1988) recorded nesting of the Indian Spotted Eagle from Keoladeo National Park, Rajasthan and Kalra *et al*. (2006) recorded it in Desert National Park, Rajasthan. The distribution map of Indian Spotted Eagle given by Naoroji (2007) shows just two records from Rajasthan: Ranthambhore Tiger Reserve, and a nesting record from Keoladeo National Park. He, however, suspected the presence of the bird in various parts of the state. This suggests that the species has a larger range and perhaps a larger population in the state, and further surveys are required to assess its distribution in Rajasthan.

BirdLife International (2014) describes Indian Spotted Eagle as Vulnerable, as it is widespread but remains a poorly known species, and is thought to have a small and declining population.

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6. SIGHTING OF ROSE-RINGED PARAKEET (BLUE) AT KACHORIYA NALA FROM RAWATBHATA, CHITTORGARH DISTRICT, RAJASTHAN, INDIA

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Rose-ringed Parakeets *Psittacula krameri*, also known as Ring-necked Parakeets, are found in India and introduced or feral populations are found in many parts of the world, to northern and west Africa in Guinea, Senegal and southern Mauritania, east to western Uganda and southern Sudan as well as South Asia (depending on the subspecies) (Forshaw 1978). These gregarious tropical parakeets are popular in the pet industry and their numbers are decreasing in some areas due to trapping for domestic pet trade (S. Kumar, ZSI, Jodhpur pers. obs.). The global population of the species has not been quantified, but it is reported to be common to abundant throughout its natural range with increasing population trend (BirdLife International 2012). Rose-ringed parakeets are popular as pets and they have a long history in Indian aviculture. The ancient Greeks kept the Indian subspecies *P. krameri manillensis* and the ancient Romans kept the African subspecies *P. krameri krameri* (Alderton 2003). *P. krameri borealis* and *P. krameri manillensis* are major agricultural pest in India (Ali and Ripley 1987). In its Asiatic distributional range, *P. krameri* is considered the worst avian agricultural pest (Dhindsa and Saina 1994).

Rose-ringed parakeets in the wild mostly have bright green plumage. The face, abdomen, and under wing-coverts are yellowish-green. The nape and the back of the head are variably washed with blue. There is a broad chin/cheek-stripe and a black narrow line from cere to eye. There is a narrow pink band to nape. The upper sides of the middle tail-feathers are blue with greenish-yellow tips. The outer feathers are green. The underside of outer tail-feathers is olive-yellowish. The middle feathers are blackish. The bill is blackish-red with black tips. The irises are yellowish-white and the feet greenish-grey. The females look like males, except that they lack the black stripe to the cheek and pink band to the nape. The nape is variably washed with blue and the middle tail-feathers are on an average shorter.

A number of colour mutations of Rose-ringed parakeets have occurred in captivity, including white (albinos), blue, grey, and yellow (lutino) (Butler 2003; Low 1992; Sullivan 2013; Williams 2015). Colour mutations of Rose-ringed parakeet have become widely available in India in recent years.

We have been living in Kachoriya nala near Tamlav village, *c.* 9 km from Rawatbhata (24.93° N; 75.58° E), in Chittorgarh district of Rajasthan for the last 20 years, but have not spotted a Rose-ringed Parakeet (blue) until December 2013. Kachoriya nala has deep gorges on both sides, rocky terrain, with many trees and shrubs like the Indian Maple and Lantana, up to Rana Pratap Sagar (RPS) Lake. Streams remain dry with small waterholes throughout the year except in the monsoon. A blue Rose-ringed Parakeet was observed with a flock of Rose-ringed parakeets with normal coloration; it had complete plumage of an adult. The bird was observed with binoculars (10 x 50x) and photographed. The adult blue parakeet had a white nape band and long tail. Tail of male was longer than the female. Lower beak black with slight red at base and upper beak dark red. The blue colour seems to be from selective breeding in aviculture. The blue parakeet could be a natural mutation or captive-bred, escaped or released from captivity, living as feral. So far, there is no report of blue, lutino, or albino parakeet from this region. We saw no resistance to the blue bird from the other normal birds in the group.

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7. SLENDER-BILLED BABBLER *TURDOIDES LONGIROSTRIS* IN RAJIV GANDHI ORANG NATIONAL PARK, ASSAM, INDIA

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On April 23, 2013, at 06:15 hrs, the first two authors (BC and MRC) observed two babblers foraging in the grasslands near Magurmari Watch Tower of Rajiv Gandhi Orang National Park (RGONP), Assam (26° 29′–26° 40′ N; 92° 16′–92° 27′ E). Later, we sighted a flock of four individuals, *c.* 50 m from the earlier site. The birds were sitting on a shrub *Leea asiatica*. The grassland was dominated by *Saccharum narenga*. We identified the birds as the Slender-billed Babbler *Turdoides longirostris*. They had a black, slender, and curved bill; reddish brown above with whitish lores and cheeks (Ali 2012; Grimmett *et al.* 1999).

The Slender-billed Babbler is distributed in the terai of Nepal, Assam, Manipur, and historically Uttar Pradesh in India (BirdLife International 2001, 2011). The species is thought to have a small fragmented population, which is declining as a result of extensive destruction and degradation of its tall grassland habitats. It therefore qualifies as Vulnerable (BirdLife International 2001, 2011). It is a sedentary resident of tall grasslands in lowlands, where it is usually found near water (Rahmani 2012). It is described as a shy grassland bird, rarely seen, and conspicuous only during the breeding season (May–June) because of its loud song (Ali and Ripley 1983).

Subsequently, we recorded this species in RGONP from April 26 to June 08, 2014, on eight occasions in Magurmari and Bhutia ali grassland. Every year during February–March, controlled burning of grasslands is carried out by the Forest Department, and it becomes easier to sight the bird in the short grass during April. Most of the grassland birds of the floodplains breed from March onwards, avoiding the heavy monsoon rain, and this species is no exception (Ali and Ripley 1987). It forages on the ground and also higher up, among grasses and reed stems (del Hoyo *et al.* 2007).

We recorded flock sizes of one to five individuals (average 2.8 ±1.4 SD, n = 10). Hume (1888) reported it in flocks of six to ten birds, but also solitary and in pairs. In Chitwan National Park, Baral and Chaudhary (2006) found that the flock size varied from 1 to 12 with larger flock sizes in April and May, compared to January to March.

Besides RGONP, there are only a few records of Slender-billed Babbler in the grasslands of Assam. In November 1993, a pair was reported near Dunga *beel* (wetland) at Bagori Range in Kaziranga National Park by Barua and Sharma (1999). Barua (2005) also reported it from Kohora, Bagori, and Agoratoli ranges in Kaziranga NP. Choudhury (2007) reported it from the grasslands of Bhuyanpara in Manas Tiger Reserve. There is no published information of its occurrence in Dibru-Saikhowa National Park (Rahmani and Choudhury 2012). Based on Abidur Rahman (pers. comm. 2012), Rahmani and Choudhury (2012) included it in the bird checklist of Orang NP. In a recent survey of 19 grasslands in Assam from February 5 to March 1, 2012, it was recorded only from Kaziranga and Manas National Parks (Phukan *et al.* 2012).

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8. JUNGLE BABBLER *TURDOIDES STRIATA* AT TANOT IN THAR DESERT, WESTERN RAJASTHAN: A RANGE EXTENSION

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The Jungle Babbler *Turdoides striata* is usually found in flocks near human habitations. It feeds on insects such as Large Ant *Monomorium indicum*, Desert Locust *Schistocerca gregaria*, and beetles and food grains like Bajra, Wheat, Jowar, and Rice. At times it is also found feeding on grass seeds (Rana 1970).

On February 07, 2014, we were conducting a bird survey in Thar desert, Rajasthan. We did a road transect for the Ramgarh–Tanot route. The entire landscape is desert, dominated by smooth sand dunes, with small patches of *Calligonum polygonoides* and *Cenchrus biflorus*, along with a few trees of *Prosopis cineraria* and *Salvadora oleoides*.

We reached Ghantiyali Mata Temple (27.76° N; 70.40° E) at 12:04 hrs and got down from our car to visit the temple. In a small garden, outside the temple, we could see some House Sparrow *Passer domesticus* and House Crow *Corvus splendens*. We were seated in the garden when we heard a familiar bird call which went *ke-ke-ke*. To our surprise, we saw a flock of Jungle Babbler on the ground close to trees and in bushes around the temple. One bird was perched at the top of a tree, observing, while the others were feeding in the leaf litter. They were medium sized babblers, much bigger than the Common Babbler *Turdoides caudata* and smaller than the Large Grey Babbler *T. malcolmi*. The tail lacked the white sides prominent in Large Grey Babbler; throat and breast were moderately mottled, lores pale, bill prominent yellow without a black tip, and the overall appearance was drab grey.

The birds matched the description of Rasmussen and Anderton (2012), and Grimmett *et al*. (2011). Jungle Babblers are commonly and frequently observed elsewhere in suitable habitat so there was no ambiguity in its identification. A photograph could not be taken, for we had to keep our equipment (camera, binoculars and GPS device) in the car, as the area is under the control of the Border Security Force (BSF).

This is the first record of Jungle Babbler from this site. Ali and Ripley (1987) reported absence of Jungle Babbler from Thar desert. Rasmussen and Anderton (2012) did not record it from westernmost Rajasthan, while the distribution map in Grimmett *et al*. (2011) shows no record of Jungle Babbler from the same area. The distribution map of Jungle Babbler on BirdLife website (2014) also lacks the presence of this bird in the reported area.

This suggests that a small population of Jungle Babbler *Turdoides striata* is present in the area in which it was previously marked as absent. Presumably, this is due to the development of plantations on both sides of the Indira Gandhi Nahar canal. Waterbodies have formed as a result of seepage from the canal that now attract many species of birds not reported earlier in the Thar desert. It is worth mentioning that the vegetation in Thar has changed from xerophytic and psammophytic to hydrophytic and mesophytic plants (Rahmani 1997).

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9. SIGHTINGS OF BUFFY FISH-OWL *KETUPA KETUPU* AND MANGROVE PITTA *PITTA MEGARHYNCHA* IN SUNDARBANS TIGER RESERVE, WEST BENGAL, INDIA

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In August and September 2014, two interesting records of uncommon bird species were obtained from Sundarbans Tiger Reserve, South 24 Parganas, West Bengal (21° 56′ 42″ N; 88° 53′ 45″ E).

Buffy Fish-owl *Ketupa ketupu*

A Buffy Fish-owl *Ketupa ketupu* was observed incubating from August 02–04, 2014. The nest was in the fork of a bare *Avicennia* tree on the edge of the water on Donbanki Island. The exterior of the old-looking nest was made entirely of sticks. The nest occupied by the owl probably belonged to an Oriental Honey-Buzzard *Pernis ptilorhynchus*, commonly occurring in the reserve and known for building stick platform nests. Later, from August 31 to September 02, 2014, a chick was noticed in the nest and photographed.

The Buffy Fish-owl *Ketupa ketupu* is the smallest fish-owl with prominent, outward-facing, tousled ear-tufts (Mikkola 2012). It is found in South Burma (now Myanmar), south and east to Trung Phan, peninsular Thailand and Malay Peninsula, Riau Archipelago, Sumatra with neighbouring islands on the western side, Mangka, Belitung, Java, Bali and Borneo (König *et al.* 1999). In the Indian subcontinent, there was no record of this species since the early 20th century from central and eastern Assam (Coltart 1904; Stevens 1915) until a record from Sundarbans East Wildlife Sanctuary, Bangladesh (Khan 2005; Neumann-Denzau and Denzau 2003). Other than these two references, there are no recent records from Assam, where presumably it was rare or extinct (del Hoyo *et al.* 1999). Its status, according to Grimmett *et al.* (1998) was not known, and there was no recent published record from this area. According to Rasmussen and Anderton (2012), Buffy Fish-owl is either very scarce or overlooked in the Indian subcontinent.

The eggs of the species are found mainly during February to April, but less commonly during May to July in West Java, or in April and September to January in Malay Peninsula (König and Weick 2008; König *et al.* 1999). However, nothing is known about its breeding habits in the Indian subcontinent and this is probably the first breeding record of the species from the Indian subcontinent. Due to inclement monsoon weather and logistical difficulties in the Sundarbans, prolonged observations were not feasible.

Mangrove Pitta *Pitta megarhyncha*

While birding from the open deck of a boat, Mangrove Pitta *Pitta megarhyncha* was heard calling almost throughout the day in the Sundarbans. One bird was sighted on August 04, 2014. This scarce species is restricted to a highly specialized and restricted habitat, and is therefore likely to have a moderately small global population. It is also suspected to be in moderately rapid decline as a result of habitat loss and degradation. It is therefore listed as Near Threatened by BirdLife International (2014).

Mangrove Pitta is sometimes considered conspecific with Blue-winged Pitta *P. moluccensis* (Lambert and Woodcock 1996; Rasmussen and Anderton 2012), and is found on the west coast of Myanmar and Malaysia, from Tenasserim in the north to Singapore in the south, Bangladesh, and Java and Borneo (Erritzoe and Erritzoe 1998).

Ali and Ripley (1983) described its status in the Indian subcontinent as 'migratory, chiefly extralimital'. A bird collected on March 19, 1925, by F. Field from Barisal, Bangladesh (Whistler 1934) is mentioned by Ali and Ripley (1983) and Rasmussen and Anderton (2012).

The disjunct range and locally variable status of the Mangrove Pitta reflect its strong preference for mangrove and coastal forests (Erritzoe and Erritzoe 1998). While Rashid (1967) felt that it was likely to occur as a summer or rainy season migrant in Bangladesh, Paynter (1970) described it as being a ‘conspicuous element of the avifauna’ in the Sundarbans of Bangladesh. It has been recorded in Bangladesh Sundarbans (Grimmett *et al.* 1998, 2011; Halder 2010; Khan 2005). Therefore, finding the bird in Sundarbans

Tiger Reserve was not unexpected. The species has been probably overlooked, as very few people venture out for birding during the monsoon season when it is most noisy and easier to sight.

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10. OBSERVATIONS ON BILL DEFORMITIES IN THREE BIRD SPECIES FROM MAHARASHTRA, INDIA

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Introduction

Reports on bill deformities in birds have been well-documented around the world (Craves 1994; Pomeroy 1962) and mainly involve grossly deformed crossed or elongated beaks. Published reports of naturally occurring bill deformities from India include long bill deformity in House Crow *Corvus splendens*, Large-billed Crow *C. macrorhynchos* and Yellow-billed Blue Magpie *Urocissa flavirostris* (Kasambe *et al.* 2009). Bill deformity has also been reported in Blue Rock Pigeon *Columba livia* (Kasambe 2010). Many reasons, like trauma or injury, poor nutrition, diseases caused by bacteria, virus, fungi, or parasitic infections, genetic mutations, chemical pollutants, and radiation, have been cited to cause bill deformities (Brown 1976; Craves 1994; Fox 1952; Marshall and Stoleson 2000; Pomeroy 1962; Sharp and Neill 1979). In this note, we discuss our observations on bill deformities in three bird species, recorded during bird trails in and around Solapur city, and possible causes behind such instances. Bill deformity in Great Indian Bustard *Ardeotis nigriceps* and Common Tailorbird *Orthotomus sutorius* is probably recorded for the first time from India.

1. Great Indian Bustard *Ardeotis nigriceps*

Bill deformity was recorded in a rescued injured adult female Great Indian Bustard (GIB) on March 04, 2012, being taken care of at Great Indian Bustard Sanctuary,

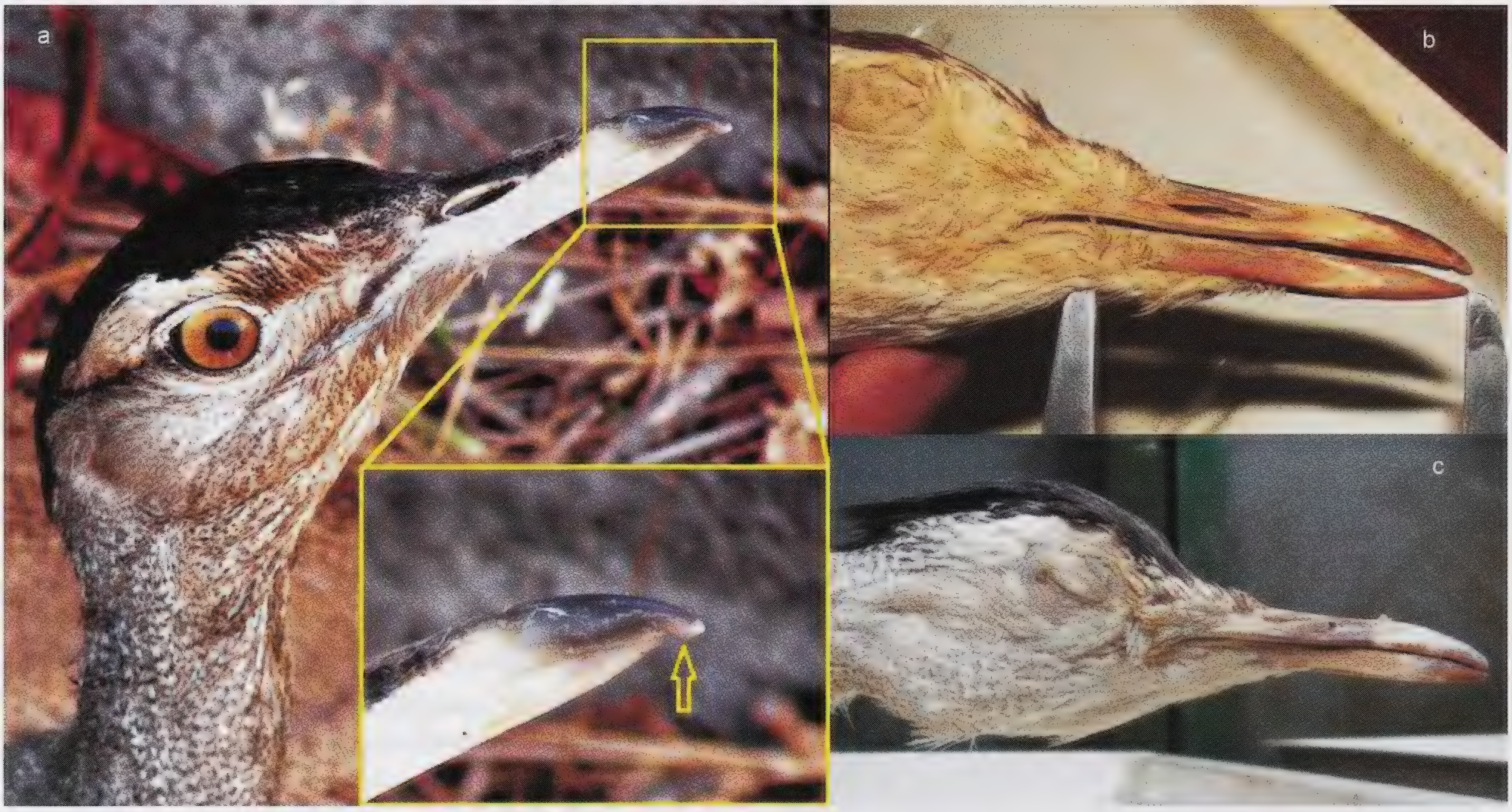

Fig. 1: Great Indian Bustard with deformed upper mandible (a) compared with normal specimens (b & c)

Nannaj, Solapur. The bird had no other visible anatomical deformity. The cause of injury could not be ascertained. The bill was abnormally long, down-curved, with a pointed upper mandible that was visibly longer than the lower, a condition referred to as long-bill deformity (Fig.1a–c). The total length of the upper mandible (maxilla) was 78.2 mm and that of the lower mandible was 68.5 mm. Measurements of the deformed GIB were compared with normal specimens from the Ornithology collection of Bombay Natural History Society, Mumbai (Table 1). Except for the abnormally long, decurved bill, all other morphological features of the deformed GIB appeared normal. This injured bustard, although well cared for, died after three months and has been preserved at Sanjay Gandhi National Park, Borivali, Mumbai.

2. **House Crow** ***Corvus splendens***

Six instances of bill deformity were recorded in House Crow from Solapur city. The deformity involved an abnormally long, down-curved and pointed upper mandible that was visibly longer compared to the lower mandible. The bill deformity was so pronounced that it could be diagnosed even with the naked eye (Fig. 2). All the six observations were recorded independently (dated 13.xii.2009; 18.ix.2010, 24.x.2010; 6.i.2011; 26.vii.2012; 12.viii.2012) during separate field surveys between January 2009 and December 2012, mostly in flocks of more than 15 crows. The crows with deformity showed normal feeding and group behaviour with other crows.

3. **Common Tailorbird** ***Orthotomus sutorius***

Only one case of bill deformity was recorded in a juvenile Common Tailorbird on October 08, 2010, from Solapur city. The upper and lower mandibles crossed each another. The upper mandible was straight. The lower mandible was longer than the upper mandible (Fig. 3). Despite having a deformed beak, the bird appeared normal and it fledged.

Table 1: Measurements of maxilla and mandible of deformed bustard specimen and normal female bustard specimens

	Specimen with deformed bill (cm)	Female Specimen with normal bill (R.No. BNHS. 14026) (cm)	Female Specimen with normal bill (R.No. BNHS. 14025) (cm)
Upper Mandible	7.82	7.23	7.06
Lower Mandible	6.85	7.19	7.01
Difference in length	0.97	0.04	0.05
Observed difference beyond crossing point of Maxilla and Mandible	0.78	Nil	Nil

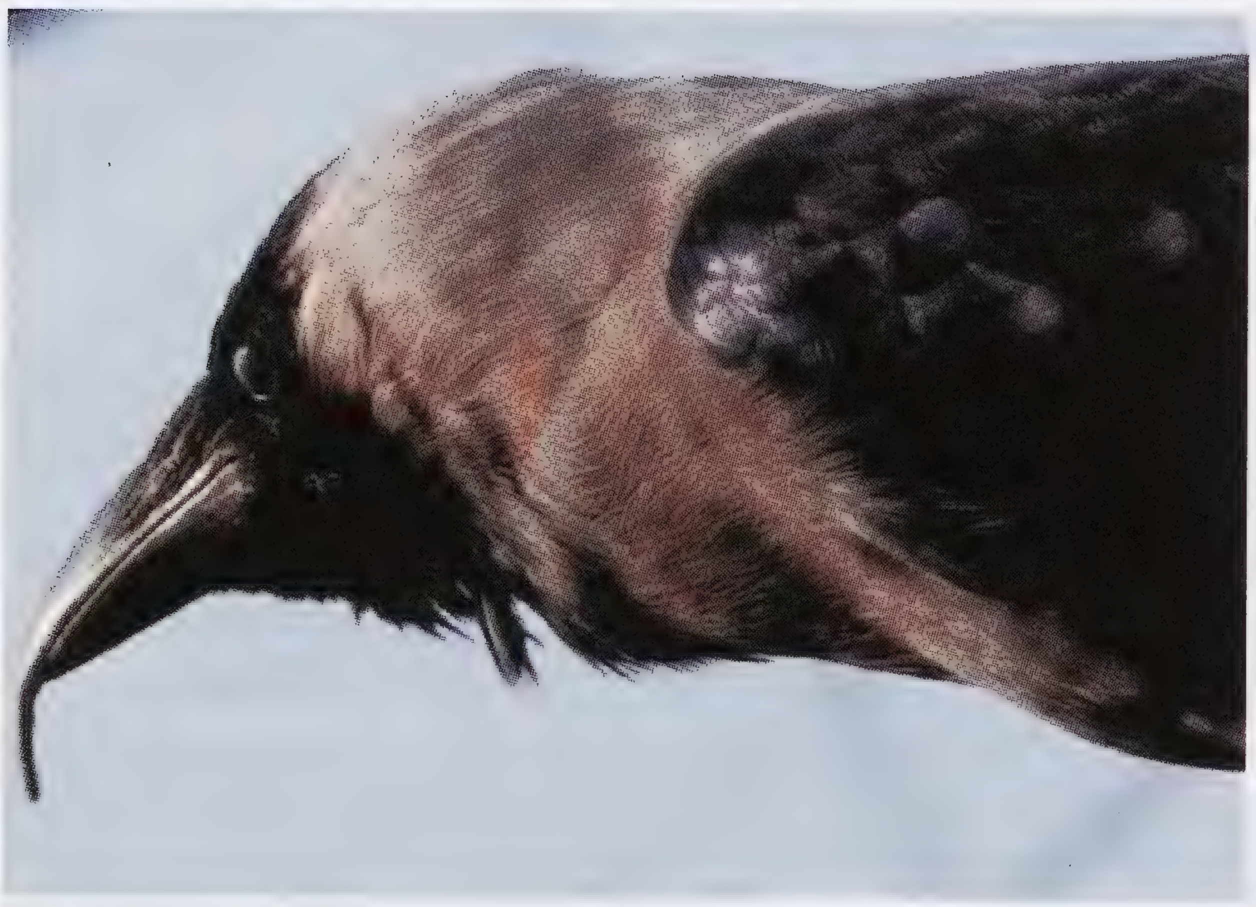

Fig. 2: Bill deformity in House Crow (Long-bill deformity)

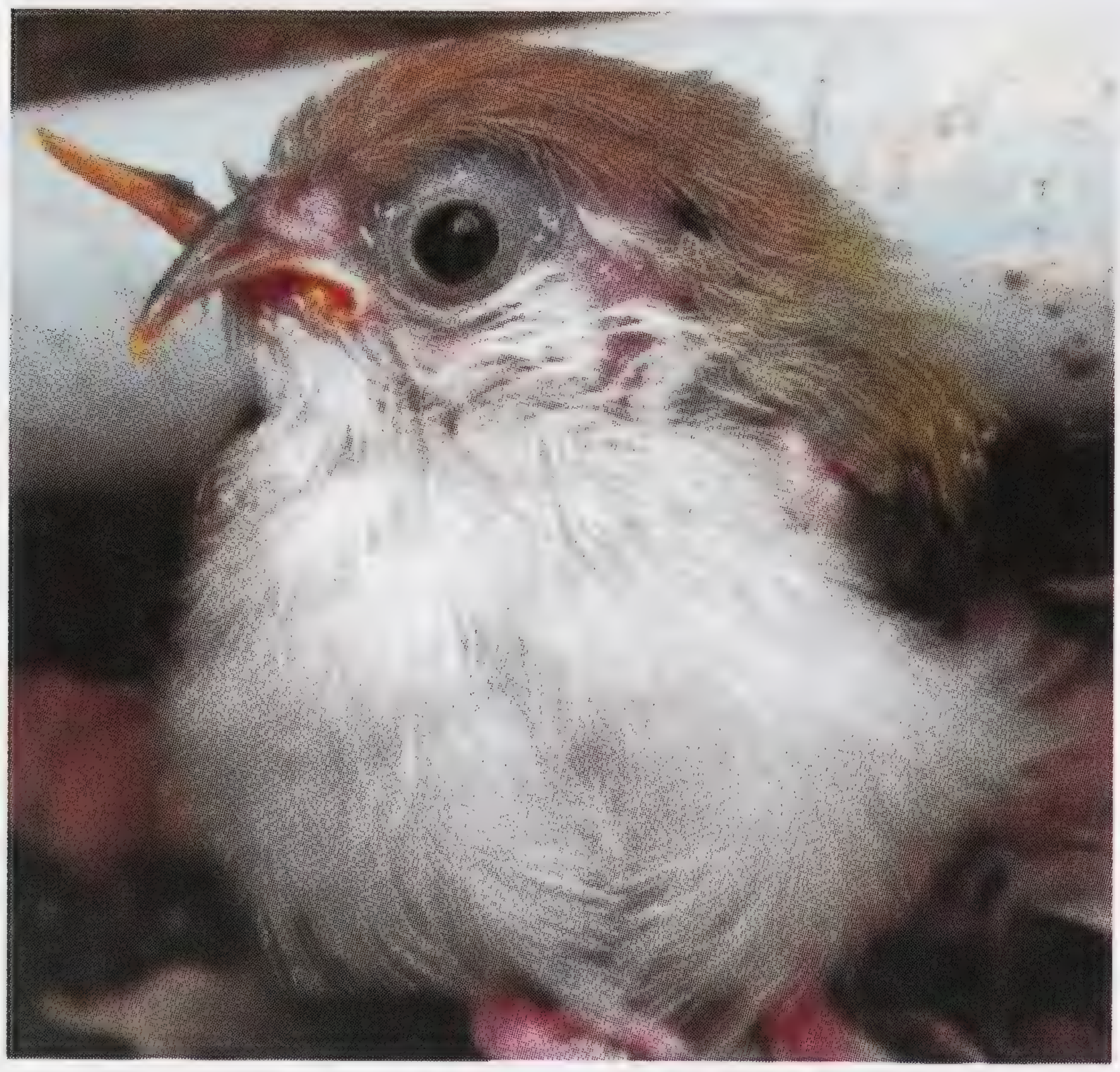

Fig. 3: Bill deformity in Common Tailorbird (Cross-bill deformity)

Conclusion

Bill deformity, although rare and statistically insignificant, raises a serious question. Is this representative of a widespread problem in the natural population, which we are not aware of or fail to assess in the wild? There is no direct observational evidence to support the impact of low population and teratogenic chemicals on the fitness of Great Indian Bustard in the wild. Being an omnivore and vagrant, GIB frequents agricultural habitats. Solapur region has experienced an overall shift in agricultural pattern from traditional sorghum based agriculture to intensive cash crops, which require high doses of pesticide round the year (Dutta *et al.* 2010). With declining population, bustards have reduced genetic diversity (Ishtiaq *et al.* 2011), which may be one of the reasons for the observed deformity.

We failed to find any published reports of Common Tailorbird with deformed beak, while there are 25 sightings of House Crow with deformed beak at 12 places in various cities from six states in India (Kasambe *et al.* 2009). The factors responsible for beak deformities in these birds are not well understood. We may speculate that these birds may be getting higher exposure to teratogenic chemicals in cities where they mainly feed on dead carcasses, of which many are killed with the use of chemicals.

The Solapur region is presently one of the most rapidly developing areas in western Maharashtra. Once known for its vast grasslands and traditional agricultural practices, Solapur region in the last decade has experienced intense urbanization, industrialization, conversion of grassland to arable land and introduction of exotic species like *Gliricidia sepium*. Grasslands from this region are currently under high peril as evidenced by the continued decline in the population of the Critically Endangered Great Indian Bustard (Hippargi *et al.* 2012). As birds are indicators of environmental health, the recent increased incidence of beak deformity poses a serious challenge. Therefore our findings are important, especially with respect to the conservation and management of Great Indian Bustard. Although our reports are incidental, more data needs to be gathered to diagnose the underlying cause and rate of prevalence of such anomalies.

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11. THE BUFF-BELLIED PIPIT *ANTHUS RUBESCENS JAPONICUS* AT RANTHAMBHORE, RAJASTHAN, INDIA

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The Buff-bellied Pipit *Anthus rubescens* breeds in central and western Siberia from Tunguska to Kamchatka and south to northern Sakhalin and the Kurile Islands. Of the four recognized subspecies, *A.r. japonicus* winters in South Asia (Ali and Ripley 1998; del Hoyo *et al.* 2004). On migration and in winter it is found in a variety of open, often wet habitats such as damp grasslands, stubble and ploughed fields, meadows, sea and lakeshores, mudflats, river courses, etc. (Alström and Mild 2003). Its status in the Indian subcontinent is variously described as uncommon winter visitor to Pakistan (Kohat, Bannu, and the plains of the Indus south to Karachi), Nepal, Darjeeling, and Manipur (Ali and Ripley 1998), "generally rare" but more frequent in north-central Pakistan (Rasmussen and Anderton 2012) rare in north-western India (Alström and Mild 2003; Grimmett *et al.* 1998), vagrant for Bhutan and recorded twice (Spierenburg 2005) and "probably a rare winter visitor and migrant in Nepal (Grimmett *et al.* 2000). Very few sightings are shown in the distribution map for the species in the Indian subcontinent (Grimmett *et al.* 2011; Kazmierczak 2000).

While birding near Jogi Mahal in Ranthambhore National Park, Sawai Madhopur district, Rajasthan on December 30, 2013, a Buff-bellied Pipit was sighted feeding in wet, grassy edges of the lake. The species was sighted again on December 31, 2013, in the same area and well observed. Many of the pipit species are confusingly similar, differing in only small morphological details which make them difficult to separate in the field (Simms 1992). However, the identification of the species at Ranthambhore was possible using a combination of field marks pertaining to wing-bar colour, overall colour, degree of streaking, thickness of malar stripe, boldness of the eye-ring, and leg colour. Moreover, having seen the species a number of times at Tal Chhapar, Churu district (Poonia *et al.* 2014) in rather open surroundings helped us in easily identifying this rare bird.

Overall it appeared small, slender and drab. Its upperparts were brown with faint streaks. Wing-bars were prominently white but not really dazzling white. Large streaks were conspicuous not only on the breast and underparts but also on the flanks. The dark coloration of the streaks contrasted strongly with the white underparts, and they were also considerably darker than the grey-brown upperparts. Some streaks coalesced longitudinally, giving a "striped" appearance (this feature was noticed in the birds at Tal Chhapar also). The face of the pipit was distinctive with complete but faint white eye-ring standing out and buffish supercilium extending behind the eye. The cheeks were grey-brown. The bill was fine and appeared dark. The legs were pink or pale brown coloured. It was separated from the similar looking Water Pipit *Anthus spinoletta* by its darker upperparts, prominent malar-stripe and paler legs.

The species is known from Bharatpur in eastern Rajasthan, as both Kazmierczak (2000) and Grimmett *et al.* (2011) show isolated record(s) from the area. However, the only confirmed record of the species in Rajasthan supported by photographic evidence is from Tal Chhapar, Churu district where it was first sighted in December 2011 and subsequently in winter months in 2012, 2013 and 2014 (Poonia *et al.* 2014).

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12. ALBINO COMMON TRINKET SNAKE *COELOGNATHUS HELENA* (DAUDIN, 1803) FROM UDAIPUR, RAJASTHAN, NORTHWEST INDIA

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On July 12, 2012, at around 24:00 hrs, we rescued an albino Trinket Snake *Coelognathus helena* (Daudin) from a house in Udaipur city. It was pale pinkish to whitish in colour with a pair of faint lines on the nape. Its characteristic oblique streak from eye to lip was not traceable. The streak on top of the head was quite faint. The ocellated crossbars of the anterior part of the body were missing. The broad dark stripes of posterior part were also faint. Its head was pale yellowish and its eyes were reddish. The tongue was reddish white, contrary to bluish grey in a normal conspecific (Sharma and Koli 2014). It was a juvenile, measuring about 350 mm in total body length. Its body scalation was: scale rows at mid body 27; supralabials 9 (5th and 6th were touching the eye); preocular 1, postoculars 2; temporals 2+2; ventrals 221; anal plate 1; subcaudals 85, paired. Sex of the snake could not be determined, since it was a juvenile. The snake was photographed for record (Fig. 1) and released in Neemach Mata Reserve Forest Block of Udaipur (North) Forest Division.

There are a few records of albinism in snakes from India (D'Abreau 1918; Jadhav and Mahabal 2012; Kumar 1988; Lahiri 1955; Nivalkar *et al.* 2012; Vyas 2009, 2012; Whitaker 1971). Various abnormal colour morphs have also been reported in Indian snakes (Vyas 2013; Vyas *et al.* 2012). A detailed account of aberrant colours and patterns in Indian serpents has been given by Mahabal and Thakur (2014). There are five published reports of total albinism in Trinket Snake *C. helena* (Mahabal and Thakur 2014) in India. So far, all cases of total albinism have been reported from Gujarat and Maharashtra, and no case has been reported from Rajasthan. The present case is the first record of total albinism in Trinket Snake *Coelognathus helena* from the state of Rajasthan, and hence worth placing on record.

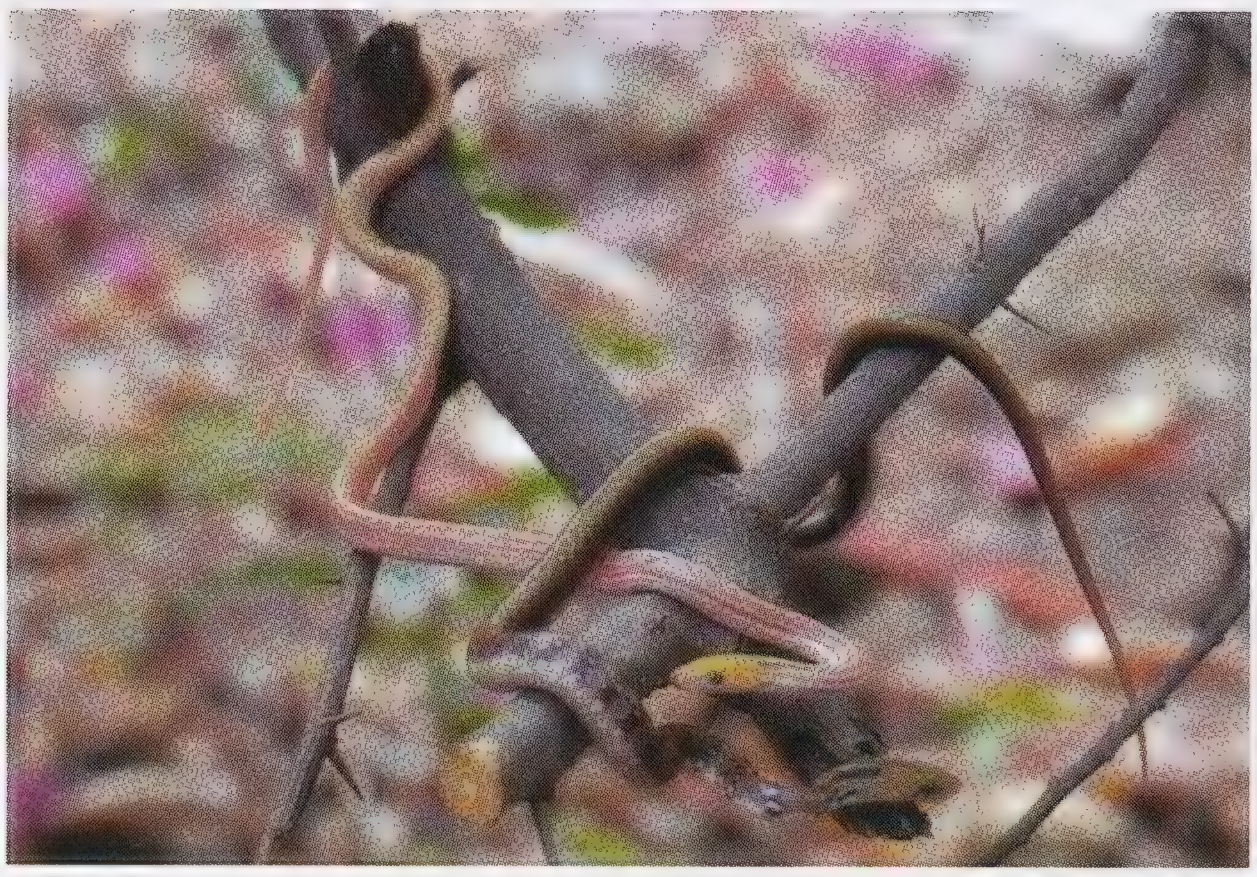

Fig. 1: Albino (rescued) and normal Trinket Snake seen in Udaipur

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13. ON A COLLECTION OF FISH FROM MANJALY – AN ESTUARINE AREA OF THE RIVER PERIYAR IN ERNAKULAM DISTRICT, KERALA, INDIA

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Introduction

Many studies have been conducted in the upper reaches of the Periyar river, but those in the lower reaches are very few. Earlier studies on the ichthyodiversity of the Periyar river date back to Chacko (1948), who listed 35 species from Periyar lake. Indra and Rema Devi (1990) collected 19 species from Thekkady Wildlife Reserve (Periyar Tiger Reserve). Arun *et al.* (1996) reported the presence of *Oreochromis mossambica* (Peters) for the first time, along with five other species from Periyar Tiger Reserve (PTR). Zacharias *et al.* (1996) collected 35 species from PTR, which included all the fishes in the list of Chacko (1948), except *Mystus cavasius* (Ham.), *M. vittatus* (Bloch), and *Notopterus notopterus* (Pallas). Raju *et al.* (2000) collected 46 species from Idukki-Neyyar Wildlife Sanctuaries. Jameela Beevi and Ramachandran (2003) reported *Danio fraseri* (Hora and Mukerji) from Periyar river. Recently, Radhakrishnan and Kurup (2010) provided an updated checklist of the fish fauna of PTR with 54 species, including 17 species additional to earlier lists. Many new species have also been reported: Menon and Rema Devi (1995) described *Hypselobarbus kurali* from Periyar lake; Menon and Jacob (1996) described *Crossocheilus periyarensis* and rediscovered *Puntius ophiocephalus* (Raj) from Periyar river; Zacharias and Minimol (1999) described *Nemacheilus menoni*, and Gopi (2001) described *Garra periyarensis* from PTR. Kurup and Radhakrishnan described *Nemacheilus periyarensis* from Periyar lake in 2005, and *Garra emarginata* and *G. mlapparaensis* from Periyar river in 2010. The present study lists 33 species of fishes collected from the estuarine area in the lower reaches of Periyar river at Manjaly. It provides a comparison with fishes collected in earlier studies from the freshwater areas of Periyar and adds 17 more species to the checklist of Radhakrishnan and Kurup (2010), raising the number to 71.

Material and Methods

A survey was conducted on the fish diversity of the estuarine area of River Periyar at Manjaly (10° 8′ 24″ N; 76° 13′ 48″ E) near North Paravur in Ernakulam district, for a period of three months from August to October 2011. Weekly samples were collected with the help of local fishermen using cast net. The samples were preserved in 10% formaldehyde and deposited in the Zoology Museum, Maharaja's College, Ernakulam, with accession numbers MCZMF 303–335. Morphometric and meristic studies were done following Jayaram (1999, 2010). Fishes were identified and classified following Day (1878), Nelson (1984), Talwar and Jhingran (1991), and Jayaram (1999, 2010).

Table 1: List of fishes collected from an estuarine area of River Periyar and comparison with earlier studies

	Fishes collected in the present study	Chacko (1948)	Indra & Rema Devi (1990)	Zacharias *et al.* (1996)	Arun *et al.* (1996)	Raju *et al.* (2000)	Radha Krishnan & Kurup (2010)
	Order : Perciformes						
	Family : Ambassidae						
	Genus : *Ambassis* Cuvier						
1.	*Ambassis ambassis* (Lacepède)* (MCZMF 303)	-	-	-	-	-	-
	Genus : *Parambassis* Bleeker						
2.	*Parambassis thomassi* (Day) (MCZMF 304)	-	-	-	-	+	+
	Family : Apogonidae						
	Genus : *Apogon* (Lacepède)						
3.	*Apogon hyalosoma* (Bleeker)* (MCZMF 305)	-	-	-	-	-	-
	Family : Terapontidae						
	Genus : *Terapon* Cuvier						
4.	*Terapon jarbua* (Forsskål)* (MCZMF 306)	-	-	-	-	-	-
	Family : Lutjanidae						
	Genus : *Lutjanus* Bloch						
5.	*Lutjanus argentimaculatus* (Forsskål)* (MCZMF 307)	-	-	-	-	-	-
	Family : Gerreidae						
	Genus : *Gerres* Cuvier						
6.	*Gerres filamentosus* (Cuvier)* (MCZMF 308)	-	-	-	-	-	-
7.	*Gerres poieti* (Cuvier)* (MCZMF 309)						
	Family : Scatophagidae						
	Genus : *Scatophagus* Cuvier						
8.	*Scatophagus argus* (Linnaeus)* (MCZMF 310)	-	-	-	-	-	-
	Family : Anabantidae						
	Genus : *Anabas* Cuvier						
9.	*Anabas testudineus* (Bloch) (MCZMF 311)	-	-	-	-	-	+
	Family : Cichlidae						
	Genus : *Etroplus* Cuvier						
10.	*Etroplus suratensis* (Bloch) (MCZMF 312)	-	-	-	-	+	-
11.	*Etroplus maculatus* (Bloch) (MCZMF 313)	-	-	-	-	+	+
	Genus : *Oreochromis* Günther						
12.	*Oreochromis mossambicus* (Peters) (MCZMF 314)	-	+	+	+	+	+
	Family : Gobidae						
	Genus : *Glossogobius* Gill						
13.	*Glossogobius giuris* (Hamilton) (MCZMF 315)	+	-	-	+	+	+
	Family : Channidae						
	Genus : *Channa* Scopoli						
14.	*Channa marulius* (Hamilton) (MCZMF 316)	-	-	+	-	+	+
15.	*Channa striata* (Bloch) (MCZMF 317)	+	+	+	+	-	+
	Order : Siluriformes						
	Family : Siluridae						
	Genus : *Ompok* Lacepède						
16.	*Ompok malabaricus* (Valen)* (MCZMF 318)	-	-	-	-	-	-
	Genus : *Wallago* Bleeker						
17.	*Wallago attu* (Bloch & Schneider) (MCZMF 319)	-	-	-	-	+	-

Table 1: List of fishes collected from an estuarine area of River Periyar and comparison with earlier studies (*contd.*)

	Fishes collected in the present study	Chacko (1948)	Indra & Rema Devi (1990)	Zacharias *et al.* (1996)	Arun *et al.* (1996)	Raju *et al.* (2000)	Radha Krishnan & Kurup (2010)
	Family : Bagridae						
	Genus : *Horabagrus* Jayaram						
18.	*Horabagrus brachysoma* (Günther) (MCZMF 320)	-	-	-	-	+	-
	Genus : *Mystus* Scopoli						
19.	*Mystus oculatus* (Valen.) (MCZMF 321)	-	-	-	-	+	-
20.	*Mystus gulio* (Hamilton)* (MCZMF 322)	-	-	-	-	-	-
	Family : Heteropneustidae						
	Genus : *Heterpneustes* Müller						
21.	*Heteropneustes fossilis* (Bloch) (MCZMF 323)	+	+	+	+	+	+
	Family : Ariidae						
	Genus : *Arius* Valen.						
22.	*Arius arius* (Hamilton)* (MCZMF 324)	-	-	-	-	-	-
	Order : Cypriniformes						
	Family : Cyprinidae						
	Genus : *Hypselobarbus* Bleeker						
23.	*Hypselobarbus thomassi* (Day)* (MCZMF 325)	-	-	-	-	-	-
	Genus : *Labeo* Cuvier						
24.	*Labeo dussumieri* (Valen.)* (MCZMF 326)	-	-	-	-	-	-
	Genus : *Puntius* (Hamilton)						
25.	*Puntius mahecola* (Valen.) (MCZMF 327)	-	-	+	-	-	-
	Genus : *Dawkinsia* (Pethiyagoda, Meegaskumbura & Maduwage)						
26.	*Dawkinsia filamentosa* (Valen.) (MCZMF 328)	-	-	+	-	+	-
	Genus : *Amblypharyngodon* Bleeker						
27.	*Amblypharyngodon melettinus* Valen.*(MCZMF 329)	-	-	-	-	-	-
	Genus : *Rasbora* Bleeker						
28.	*Rasbora daniconius* (Hamilton) (MCZMF 330)	+	+	-	+	-	+
	Order : Beloniformes						
	Family : Belonidae						
	Genus : *Xenentodon* Regan						
29.	*Xenentodon cancila* (Hamilton) (MCZMF 331)	-	-	-	-	+	+
	Family : Hemiramphidae						
	Genus : *Hyporhamphus* Gill						
30.	*Hyporhamphus limbatus* (Valen.)* (MCZMF 332)	-	-	-	-	-	-
	Order : Mugiliformes						
	Family : Mugilidae						
	Genus : *Mugil* Linnaeus						
31.	*Mugil cephalus* (Linnaeus)* (MCZMF 333)	-	-	-	-	-	-
	Order : Clupeiformes						
	Family : Clupeidae						
	Genus : *Dayella* Talwar & Whitehead						
32.	*Dayella malabarica* (Day)* (MCZMF 334)	-	-	-	-	-	-
	Order : Elopiformes						
	Family : Megalopidae						
	Genus : *Megalops* Lacepède						
33.	*Megalops cyprinoides* (Broussonet)* (MCZMF 335)	-	-	-	-	-	-

+ indicates presence of species; - indicates absence of species; * indicates species collected in the study and not recorded in the compared lists

Results and Discussion

A total of 33 species of fishes belonging to 28 genera, 20 families, and 6 orders were collected. Order Perciformes dominated the study with 10 families, 12 genera and 15 species, followed by Order Siluriformes with 4 families, 6 genera and 7 species. Order Cypriniformes was represented by a single family, Cyprinidae with 6 genera and 6 species. Order Beloniformes was present with 2 families, 2 genera and 2 species. Orders Mugiliformes, Clupeiformes, and Elopiformes were represented by one species each. A comparative list of the collected fishes with their systematic positions and accession numbers is given in Table 1.

Of the collected fishes, the only exotic species – *Oreochromis mossambica* (Peters) – was present in all previous checklists except in Chacko (1948). It was reported for the first time by Arun *et al.* in 1996 from Periyar lake. *Apogon hyalosoma* (Bleeker) collected during the study was the first report of the species from Kerala (Shyla and Jameela Beevi 2014). The only species of genus *Puntius* collected during the study was identified as *Puntius mahecola* Valenciennes (MCZMF 327), based on the presence of a caudal spot, a single pair of maxillary barbels, and lateral line scales being 22(1)–23(2) (Pethiyagoda and Kottelat 2005). The *Hypselobarbus* sp. collected during the study (lateral line scales 32, Ltr 5 1/2 / 1/2 1/2, predorsal scales 11) was identified as *H. thomassi* Day (MCZMF 325) as per Knight *et al.* (2013a, b). Other than the four species, namely *Heteropneustes fossilis* (Bloch), *Rasbora daniconius* (Hamilton), *Glossogobius giuris* (Hamilton), and *Channa striata* (Bloch) mentioned in Chacko (1948), *Wallago attu* (Schneider), a near threatened species (IUCN Red List 2012.2), was collected and recorded in the study. Sixteen species collected in the present study were previously reported from Periyar. Most of the species collected during the study, like *Ambassis ambassis* (Lacepède), *Terapon jarbua* (Forsskål), *Lutjanus argentimaculatus* (Forsskål), *Scatophagus argus* (Linnaeus), *Amblypharyngodon melettinus* (Valenciennes), *Ompok malabaricus* (Valenciennes), *Dayella malabarica* (Day), *Megalops cyprinoides* (Broussonet), *Mugil cephalus* (Linnaeus), *Mystus gulio* (Hamilton), *Arius arius* (Hamilton), *Gerres filamentosus* (Cuvier), *G. poieti* (Cuvier), *Hyporhamphus limbatus* (Valenciennes), *Labeo dussumieri* (Valenciennes), *Hypselobarbus thomassi* (Day), are estuarine forms or species visiting lower reaches, and hence not reported earlier. Many freshwater species of *Garra*, *Anguilla*, *Tor*, *Salmophasia*, *Barilius*, *Devario*, *Danio*, *Macrognathus*, *Crossocheilus*, *Nemacheilus*, *Bhavania*, *Travancoria*, *Schistura*, *Batasio*, *Lepidocephalus*, *Glyptothorax*, *Clarias*, *Poecilia*, *Mastacembelus*, and *Pristolepis* were not collected from Manjaly as it is an estuarine habitat. Most of the collected fishes, despite their food value, have great demand in the ornamental fish market, either in the young or adult stage (Beevi and Ramachandran 2009).

This study highlights the richness of estuarine ichthyofauna of Periyar river with the report of 17 additional species. If 33 species could be collected within three months, a year-long collection may add more species to the list.

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14. SEXUAL DIMORPHISM IN A BENTHIC FISH *OXYURICHTHYS TENTACULARIS* (VALENCIENNES, 1837), GOBIIDAE, INHABITING ASHTAMUDI ESTUARY, KERALA, INDIA

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Introduction

Members of the Gobiidae family are small benthic fishes inhabiting a wide range of habitats in temperate and tropical regions (Nelson 1994). *Oxyurichthys tentacularis* (local name Koozhali) is one of the important Gobiid food fish of Ashtamudi estuary. Though its abundance and distribution

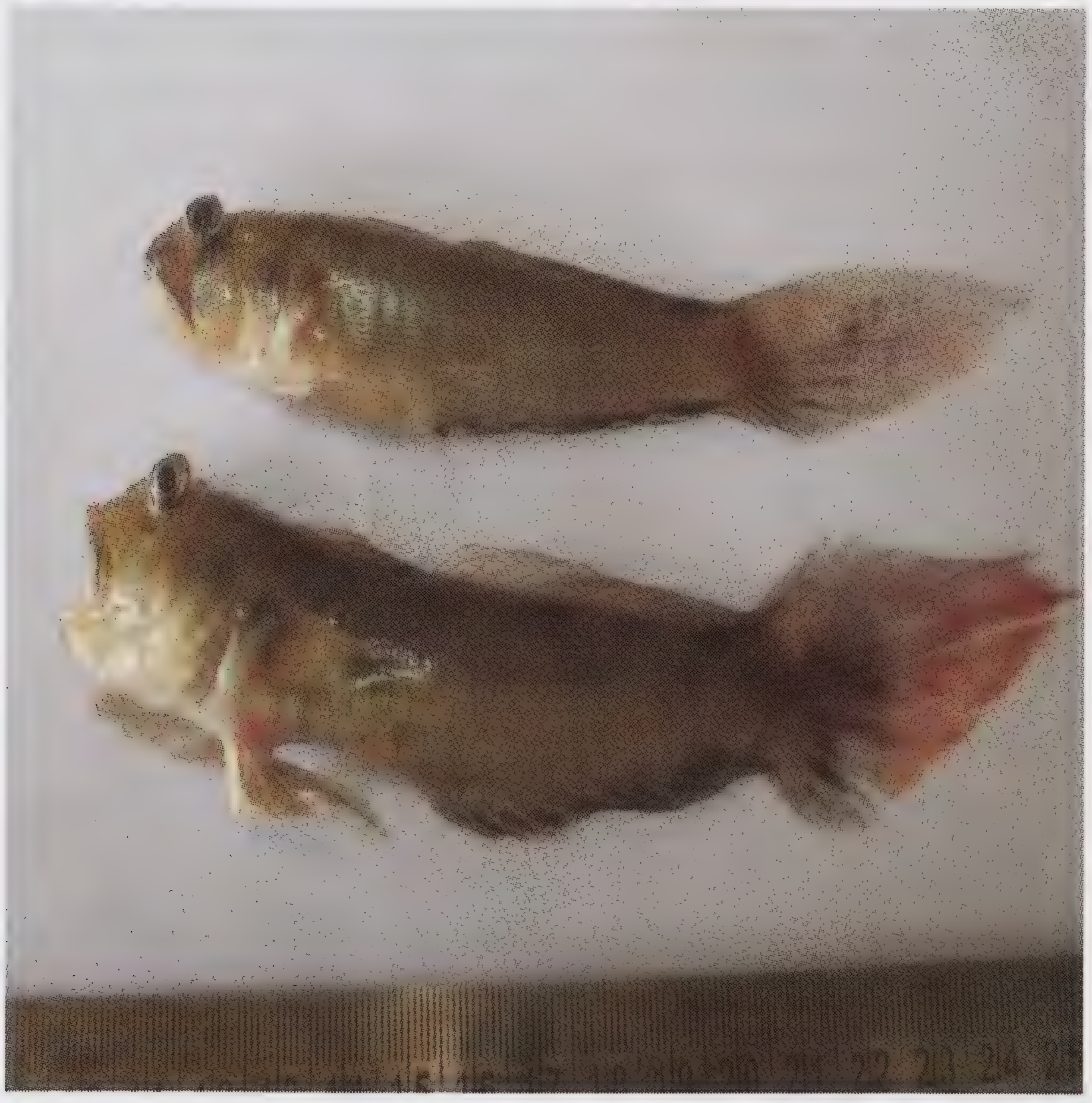

Fig. 1: *Oxyurichthys tentacularis* male (lower) and female (upper)

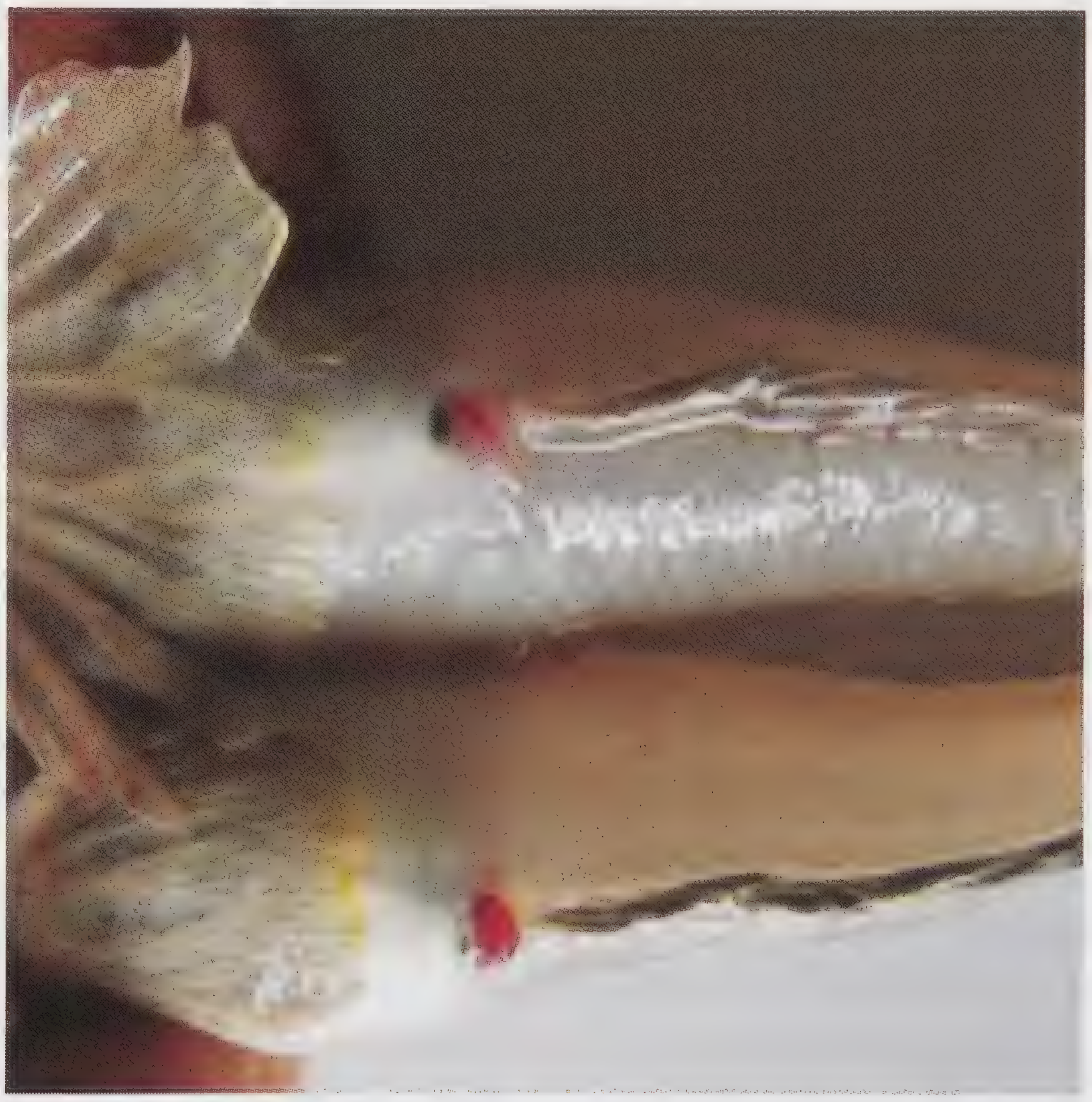

Fig. 2: Urogenital papilla of male (upper) and female (lower) *Oxyurichthys tentacularis*

is noted in other estuaries and backwaters of India, Ashtamudi estuary is the only estuary in India where a gobiid is fished commercially (Kurup and Thomas 2001). Sexual dimorphism study is the preliminary step to distinguish sexes of a species. Such studies have been carried out only on a few fish species in India. Given the lack of biological or ecological data on *Oxyurichthys tentacularis*, the objective of this work was to document its sexual dimorphism.

A total of 725 specimens were analyzed for the study. The specimens were collected from Ashtamudi estuary (8° 52′–9° 2′ N; 76° 32′–76° 41′ E), in Kollam, for a period of one year from August 2013 to September 2014. Specimens of *Oxyurichthys tentacularis* were collected using modified gill nets, locally known as *koozhalivala*. Freshly collected specimens were brought to the laboratory and studied. The colour pattern in the sexes was noted in the fresh catch. Total length and weight were measured. Sex was determined by observing the appearance of the gonads through the naked eye.

Macroscopic features of the male and female fish were noted to document sexual dimorphism. The sexes of *O. tentacularis* can be distinguished by differences in the urogenital papilla, which is in the ventral region between the anal orifice and the anal fin origin. The urogenital papilla is short, blunt, and pinkish in females, while in males it is thin, pointed, pale, and smooth (Figs 1 and 2). In both sexes, the urogenital papillae are covered only by epithelium and not by scales. In most cases, male fishes are larger, head rather long, compressed, a darker olive green body, and longer fin rays than female fishes of similar length.

Minos *et al*. (1995), while studying Red Porgy *Pargus pargus* stated that the dimorphic characters may reflect the adaptation of males and females to different social or/and reproductive roles rather than different niche utilization. This is the first report of sexual dimorphism in *Oxyurichthys tentacularis*.

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15. A NOTE ON THE OCCURRENCE OF *BINDAHARA PHOCIDES* (FABRICIUS) (LEPIDOPTERA: LYCAENIDAE) AS A FRUIT BORER OF *SALACIA FRUTICOSA* HEYNE EX LAWSON AT PEECHI, KERALA, INDIA

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Introduction

Bindahara phocides (Fabricius) is a rare butterfly, listed under Schedule II of the Indian Wildlife (Protection) Act (1972). Mostly found in evergreen forests, it is a swift flier and typically active in the late afternoon or early evening. It spends much of its time in shady and thickly vegetated areas among the canopy. It is able to fly quickly and the flight is reminiscent of tailed Lycaenids like Common Imperial *Cheritra freja* Fabricius. According to D'Abrera (1986), it occurs in two forms, namely *phocides* and *moorei*. *Bindahara phocides moorei* is reported from southern India and Sri Lanka and *B. phocides phocides* from Sikkim eastwards (Kehimkar 2008).

Salacia is a genus of the plant family Hippocrateaceae, consisting of about 200 species distributed in tropical America, Africa, and Asia. In India, it is represented by 21 species, of which 15 are known from Peninsular India. Of the 9 species of *Salacia* known from Kerala (Udayan *et al.* 2012), *S. macrosperma* and *S. reticulata* are listed as larval food plants of *Bindahara phocides* (Kunte 2000). Ilse and Nafus (1997) reported *Salacia prinoides* (= *Salacia chinensis*), a climbing shrub, as a host of *Bindahara phocides* in Asia.

Salacia fruticosa is a medicinal shrub, occurring in southern India. Its root is used in traditional Indian medicine for treating diseases, particularly diabetes (Premila 2009). The species is locally called *Ekanayakam* or *Ponkarandi* in Kerala. Fruits of *S. fruticosa* are 2–3 cm across, globose and bright orange or orange-red in colour, containing 1–4 seeds. The seeds are covered with fleshy sweet aril. Ripe fruits are available during February to July. Recently, caterpillars of *Bindahara phocides* were found to bore into the fruit of *Salacia fruticosa* at Peechi, Kerala, and information on the biology and pest status of the insect is presented in this note.

Methodology

Premature falling of fruits of *S. fruticosa* was noticed in the Medicinal Plants Garden of Kerala Forest Research Institute, Peechi, Kerala, during May 2013. Ten infested fruits were collected from the field and on examination were found to be eaten up by an unidentified caterpillar. The infested fruits were placed in small glass jars of 16 x 10 cm, covered with a clean, dry cloth securely fastened with a rubber band. The jars were kept moist by placing a small piece of wet cotton within. All frass and excreta were removed daily. Ten larvae were reared in the laboratory and all of them completed their life cycle successfully.

Results and Discussion

Infestation was evident from the small pin-hole like mark present on the pericarp. The larva inside the fruit grew by feeding on the fleshy aril and seed. As the larva grew, the contents of the fruit including the seed were completely eaten up and the frass and excreta were ejected through the hole on the pericarp. During the initial stage of infestation, the width of the hole is around 0.5–1 mm and gradually as the larva grew inside, the hole increased in size. When the larva attained full maturity, the opening measured 6–10 mm in width.

The fully-grown larva is black with the head and tip of abdomen yellow, measures 15–20 mm in length with the head region having a width of about 0.04 mm. It is dorso-ventrally compressed and possesses lateral bulgings. The first as well as parts of the second and third thoracic segments and some dorsal sclerites of the abdomen have a brownish tinge. It has a broad white band in the middle and the head capsule is more flattened and differentiated from the body. The larva, which is sluggish in habit, is slimy. Prior to the pupation, the larva becomes inactive and pupation occurs within the fruit. The total duration of larval period lasts for 15–18 days.

The pupa, which measures 10–15 mm in length, is smooth, tubular and brown in colour. Prior to eclosion, the pupa turns dark brown in colour. The pupal stage lasts for 7–12 days, after which the adult hatches out. The total life cycle is completed in about 30 days.

Conclusion

Salacia fruticosa is used for the treatment of diabetes, rheumatism, gonorrhea, and skin diseases. The natural propagation of *S. fruticosa* is through seeds. Even though a mature plant produces several seeds per season, this plant is rather rare and this could be due to fruit damage caused by *Bindahara phocides*. As it supports one of the rarest and protected butterfly species, and considering the demand for this medicinal plant, systematic cultivation of *S. fruticosa* may be undertaken.

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16. *PAPILIO XUTHUS* LINNAEUS (LEPIDOPTERA: PAPILIONIDAE) – A NEW RECORD FOR INDIA

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Introduction

Papilio xuthus Linnaeus is a common Asian butterfly, known to occur from Japan (Yokoyama 1955) through China to northern Vietnam (Yutaka 2015) and northern Myanmar (Evans 1932). It is common throughout the range except in northern Myanmar, where Evans (1932) noted it to be very rare.

Although *Papilio xuthus* is similar to *P. machaon* Linnaeus, Remington (1959) noted that *P. xuthus* in its early stages, is a Rutaceae feeder and much closer to *P. demoleus* Linnaeus, *P. polytes* Cramer, and *P. liomedon* Moore, rather than the Umbelliferae-feeding *P. machaon* group.

Although several subspecies and forms have been proposed, Yutaka (2015) lists these as synonyms, including *Papilio xanthus neoxuthus* Fruhstorfer recorded from Ta-Tsien-Lu village, not very distant from the present record. Therefore, it is proposed to follow the treatment of Yutaka (2015) and regard the taxon *P. xuthus* as having no discernible, consistent geographical variation.

It is known to migrate up to 200 km (NatureServe 2013). It has been reported to be on the wing from May to September (http://lepidoptera.pro/taxonomy/15093).

Material and Methods

On March 13, 2014, *Papilio xuthus* was photographed in Walong town (28° 8′ N; 97° 1′ E), Anjaw district, in the extreme east of Arunachal Pradesh. A group of around 10 individuals were observed feeding on flowers of a rosaceous tree, perhaps a wild cherry for 10 minutes. During this encounter, both the upperside and underside were clearly photographed, to confirm the identity of the butterfly.

Papilio xuthus differs from *P. machaon* and other Asian members of the *machaon*-group, by the forewing cell having dark streaks on a yellow ground, rather than yellow sprinkled with some dark scales.

No other butterflies were observed on the wing during that period. The presence of so many individuals together on the same tree suggests that they might be members of the same brood. They might also breed in the area.

Remarks

The present report extends the known distribution of this butterfly to India. It was recorded in June in Vietnam (Yutaka 2015). The current record confirms that it is on the wing even earlier, in March. Since *Papilio xuthus* is known to migrate, one cannot be certain if the individuals photographed in Walong were members of a breeding population or part of a dispersal from its known habitat further east. The presence of so many individuals feeding on the same tree also suggests that they might have gathered on the only nectar resource available at that time of year. We did not see any other flowering trees during our visit to the area.

It needs to be confirmed whether this butterfly actually breeds in the area, and if so, its seasonality in India. The report by Evans (1932) that it is "Very Rare" was in all likelihood a reflection of its status in collections at that time rather than an assessment of its actual status in nature. Since it is common over most of its known distribution, there is no need to consider it 'threatened' or 'endangered' since the main reason for its recent discovery is that no one had really looked for butterflies in that area earlier.

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17. GEOGRAPHICAL CONVERGENCE PATTERNS IN THE DISTRIBUTION OF *DROSOPHILA* SPECIES IN NAGALAND, A SUB-HIMALAYAN HILLY STATE OF NORTH-EAST INDIA

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Introduction

The fruit fly *Drosophila* is one of the most intensively studied organisms in biology that serves as a model system for investigations of many developmental and cellular processes, disease, adaptation, diversity, and evolution, whose underlying fundamental principles are comparable to higher eukaryotes, including man (Devineni and Ulrike 2013).

Significant progress has been made in the field of taxonomy and systematics of the family Drosophilidae (Order: Diptera) in India. However, a vast area of great ecological interest is poorly explored. Particularly, very little is known regarding *Drosophila* fauna of the north-eastern region of the Indian subcontinent. This region, with its diverse climatic conditions, variable altitudes, deep valleys, luxuriant flora, streams and moist habitats, is one of the richest repositories of biodiversity in the world (Chatterjee *et al.* 2006). It provides an ideal location for colonization of several *Drosophila* species (Achumi *et al.* 2011, 2013; Dwivedi 1979; Dwivedi *et al.* 1979; Gupta and Singh 1979; Singh 1987; Singh and Gupta 1977; Yenisetti *et al.* 2002).

Some *Drosophila* species have been reported from the Northeast. Dwivedi (1979) reported two new species of genus *Drosophila* (*Drosophila guptai* and *D. ramamensis*) from Darjeeling, West Bengal. Gupta and Singh (1979) reported 7 species including 2 new species *Drosophila novaspinofera* and *D. penispina* from Shillong, Meghalaya. Gupta and Singh (1981b) reported two new species *D. paralongifera* and *D. neomakinoi* from Rimbick, West Bengal. Kumar and Gupta (1983) reported 18 species from Meghalaya and Arunachal Pradesh. Singh (1987) reported 11 species of *Drosophila* from Dimapur, Medziphema, and Kohima of Nagaland. Yenisetti *et al.* (2002) reported 8 species of *Drosophila* from Mokokchung, Nagaland. Achumi *et al.* (2011) reported one new species *Drosophila hegdii* from Lumami, Nagaland. Achumi *et al.* (2013) also reported 19 species from Mount Japfu of Nagaland.

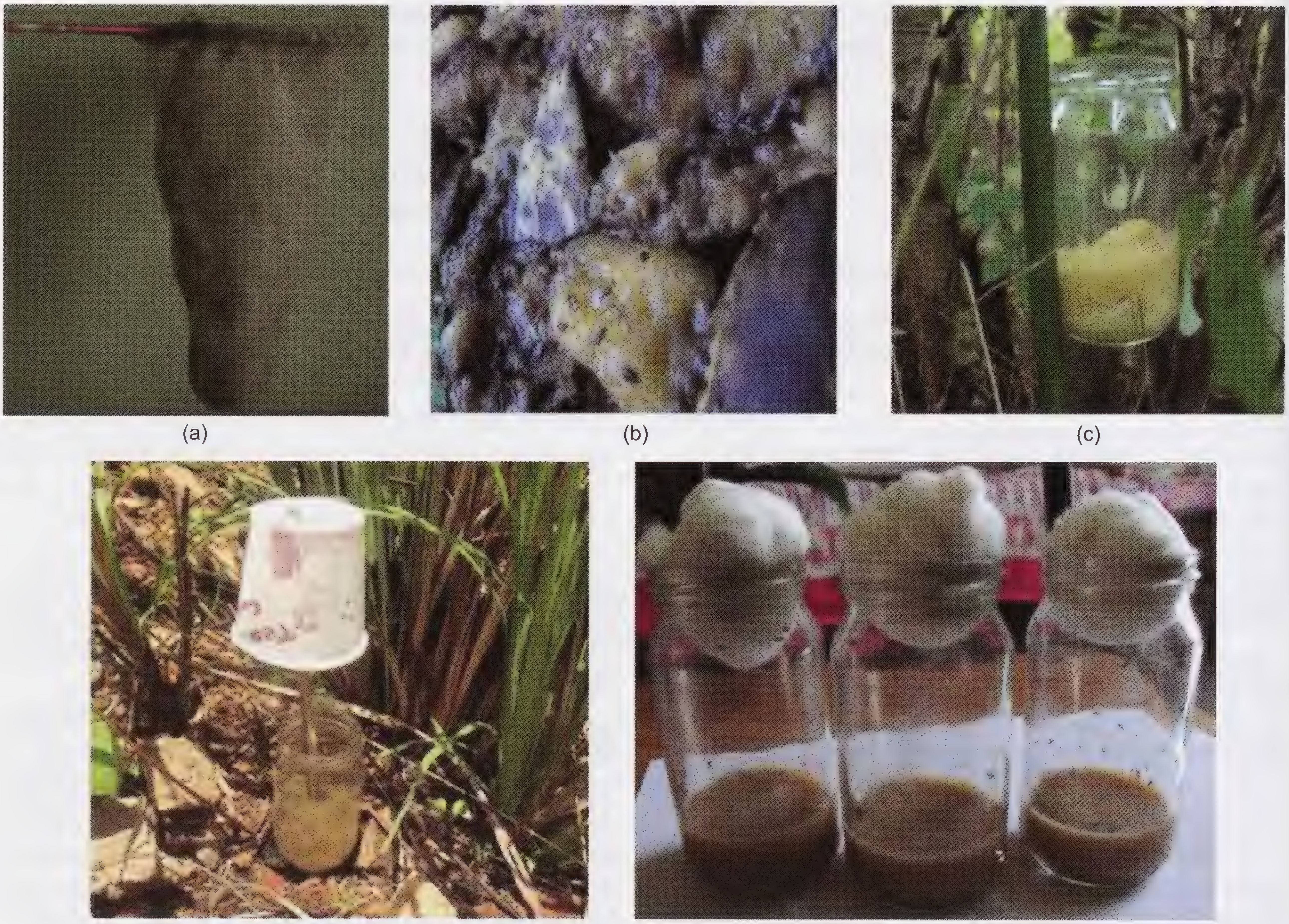
No systematic comprehensive study has been done on the *Drosophila* diversity of Nagaland. Singh (1987) conducted a pioneering preliminary survey on Drosophilids of Dimapur, Medziphema, and Kohima of Nagaland. Yenisetti *et al.* (2002) published a preliminary report on Drosophilids of Mokokchung. Achumi *et al.* (2011) recently described *Drosophila hegdii* from Lumami in Zunheboto district. As most parts of Nagaland are unexplored areas, in order to understand distribution patterns of *Drosophila* species, collections were made from wild localities of all 11 districts of Nagaland.

Material and methods

Collections were made from wild localities of 11 district headquarters of Nagaland state post-monsoon in 2012 (post-monsoon period October to December is ideal for proliferative growth of Drosophilids in the wild, due to the availability of food and rotting substrates).

Drosophila collections were made following two methods (Fig. 1):

1) **Bottle trapping method**: For this method, milk bottles of 200 ml capacity containing a mashed ripe banana sprayed with yeast were tied to twigs underneath small bushes at 0.9 m to 1.5 m above the ground. Ten traps were kept in an area of 1 km radius. After 2 days, the mouth of the bottle was plugged with cotton and removed from the bushes. The flies attracted to the bait were thus trapped and collected in the bottles soon after sunrise or just before sunset. The collected Drosophila were later transferred to fresh bottles containing wheat cream agar medium, prepared as follows:



(a) (b) (c)

(d) (e)

Fig. 1: Drosophila collection from wild localities: (a) Drosophila collection net (b) Spreading of bait for net sweeping method (c) Arrangement for bottle trapping method (d) Ice cream cup covered over the bottle during rainy season (e) Culturing Drosophila collected from the wild in bottles containing soji, jaggery and agar medium in the laboratory

100 gm sugar (jaggery) was added to 500 ml water, boiling it with gentle stirring till the jaggery dissolved. Then, 500 ml water, 100 gm semolina (soji), and 8 gm agar-agar were added to the boiling sugar-water mixture. When the medium turned sticky, 7.5 ml propionic acid (antifungal agent) was added while continuously stirring the medium, which became a thick fluid. The medium was then distributed to sterilized glass bottles (200 ml milk bottles) or vials of 1" x 3" size. The mouth of the bottles/vials was kept closed with cotton. Next day, moisture was removed from the bottles/vials and two drops of yeast solution were added to the medium. This medium was used after 24 hours.

2) **Net sweeping method**: For this method, a handmade *Drosophila* net containing a fine cloth cone tied to the rim of the net was used. Sweeping was done on fermenting fruit (crushed bananas were spread in shady areas of bushes in the wild, and flies were collected after 2 days) that were spread out in four shady regions in an area of 1 km radius. After each sweep (three sweeps were performed), flies were collected at the bottom of the cone of the net and were transferred to the bottles containing freshly prepared wheat cream agar medium.

The flies were then brought to the laboratory, isolated, and the sex identified. The males were directly used for identification of species on the basis of morphological characters such as presence or absence of the sex comb; if present, the number of sex comb rows and teeth in each row were recorded and the characteristics of the genital plate were studied. Individual females were kept in separate food vials and allowed to produce isofemale lines. The males of the F1 progeny of these gravid females were used for species identification.

Genital plate of male *Drosophila* was dissected by keeping the fly on a glass slide under a dissecting microscope with one or two drops of 0.7% NaCl (invertebrate physiological saline). The tip of the abdomen was immersed in a solution of 4% KOH for 15–20 minutes to clear the soft tissue. The genital plate was mounted in glycerol on a cavity slide. The slides were observed under low (10x) and high (40x) magnification with a microscope. Similarly, the sex comb, which is present on the foreleg of the male fly, was dissected out by keeping the fly on a glass slide with one or two drops of 0.7% NaCl. The sex comb was mounted in glycerol on a clean glass slide. After placing the cover glass, slides were observed under low (10x) and high (40x) magnification under a microscope.

The collected *Drosophila* flies were taxonomically identified by employing the parameters suggested by Bock (1971), Patterson and Stone (1952), Sturtevant (1921), and Throckmorton (1962). The most important specific characters are the morphological features, like colour and size of imago, number and nature of aristal branches, nature and arrangement of genital arch, nature and number of acrostichal hairs, wing length and indices, the internal characters of the adults, shape and number of egg filaments, pupal characters, pupal spiracles, and behaviour.

Diagnostic features of the species collected:

1. Abdomen of male entirely pale brown; sex comb on first tarsomere in two rows (six basal, eight distal teeth) single setae present on second tarsomere ....*D. bipectinata* (Duda, 1923).
2. Yellowish overall, with longitudinally striped pleurae; preapical setae absent on second and third tibiae ....*D. buskii* (Coquillet, 1901).
3. Sex comb with only two strong setae ....*D. eugracilis* (Bock and Wheeler, 1972).
4. Secondary clasper partially connected, three large setae present on secondary clasper, and these setae are larger dorsally ....*D. hegdii* (Achumi *et al.* 2011).
5. Secondary clasper nearly oval in shape; larger medial seta on secondary clasper inserted dorsally. ....*D. jambulina* (Parshad and Paika, 1964).
6. Abdominal tergites yellow to rufous, with dark posterior bands in both sexes; spare rows of large setae ....*D. kikkawai* (Burla, 1954).
7. Tips of longitudinal veins black, male foreleg 1st tarsomere with a dense cluster of fine hair ....*D. immigrans* (Sturtevent, 1921).
8. Sex comb with single row on basitarsus (three teeth) and two rows on second tarsomere (one basal and two distal teeth)............................*D. malerkotliana* (Prashad and Paika, 1964).
9. Sex comb present on the fore tarsus of male, primary clasper only present........................ *D. melanogaster* (Meigen, 1830).
10. Abdominal pattern reduced in both sexes. Male frons strongly whitish, pruinose when viewed from certain angles. First basitarsus of male normal .... *D. nasuta* (Lamb, 1914).
11. Two prominent setae present on anal plate; secondary clasper oval, with single large black seta .... *D. parvula* (Bock and Wheeler, 1971).
12. Inner margin of femur with a row of stout, peg-like setae, this row is poorly developed...*D. paraimmigrans* (Gai and Krishnamurthy, 1986).
13. Metatarsus of fore leg in male with sex comb in two rows, proximal row with 6 to 7 teeth and distal row with 3 teeth. Genital arch carries 25 to 30 bristles. Primary clasper independent of genital arch, roughly triangular, bent interiorly and accommodates a primary row of 6 to 7 teeth; secondary row with 3 to 4 teeth present at posterior outer angle of primary clasper ....*D. rajasekari* (Reddy and Krishanamurthy, 1968).
14. Apical band on tergites not widened to form a triangle in the lateral area; scutum grey, with many dark brown spots ....*D. repleta* (Wollaston, 1858).
15. Primary surstylus with a ventrolateral comb of long, rounded, black setae, only a few teeth dorsolaterally ....*D. takahashii* (Sturtevent, 1927).
16. Three subequal katepisternal setae present; prescutellar acrostichal setulae present ....*D. nigra* (Meijere, 1908).

Results

The list of *Drosophila* species collected in 11 districts of Nagaland and their taxonomic position is shown in Table 1. Total of 16 species were collected, belonging to four subgenera, namely *Sophophora*, *Drosophila*, *Dorsilopha*, and *Scaptodrosophila*. Pooled data collected from 11 districts yielded a total of 2,326 individuals. Out of these, 1,463 individuals (62.89%) belonged to 10 species of subgenus *Sophophora*; 569 individuals (24.46%) belonged to 4 species of subgenus *Drosophila*; 121 individuals (5.20%) belonged to 1 species of subgenus *Dorsilopha*; the remaining 173 individuals (7.43%) belonged to 1 species of subgenus *Scaptodrosophila*.

Drosophila fauna at Dimapur

Analysis of *Drosophila* collection of 279 flies from this locality revealed the occurrence of 14 species representing four subgenera, namely *Sophophora*, *Drosophila*, *Dorsilopha*, and *Scaptodrosophila*, of the genus *Drosophila*. Out of these, 187 individuals (67.02%) belonged to 8 species of subgenus *Sophophora*, namely *D. bipectinata*, *D. eugracilis*, *D. jambulina*, *D. kikkawai*, *D. malerkotliana*, *D. parvula*, *D. melanogaster*, and *D. takahashii*. 59 individuals (21.14%) belonged to 4 species of the subgenus *Drosophila* (*D. immigrans*, *D. nasuta*, *D. repleta*, and *D. paraimmigrans*). 22 individuals (7.88%) belonged to 1 species of subgenus *Dorsilopha* (*D. buskii*). The remaining 11 individuals (3.94%)belonged to 1 species of subgenus *Scaptodrosophila* (*D. nigra*).

Table 1: Occurrence and distribution pattern of Drosophila species in 11 districts of Nagaland state, India

Species	Dimapur	Kiphire	Kohima	Longleng	Mokokchung	Mon	Peren	Phek	Tuensang	Wokha	Zunheboto	Total
Genus: *Drosophila*												
Subgenus: *Sophophora*												
1.*D. bipectinata*	25	26	40	–	14	–	27	19	30	11	28	220
2. *D. eugracilis*	34	–	24	35	19	18	20	21	11	13	–	195
3. *D. jambulina*	23	–	18	–	27	25	10	12	7	21	19	162
4. *D. kikkawai*	28	19	17	–	–	30	–	31	23	–	27	175
5. *D. malerkotliana*	22	18	30	42	17	16	29	–	26	33	–	233
6. *D. parvula*	15	12	25	–	29	29	18	–	–	10	12	150
7. *D. melanogaster*	12	15	09	06	11	10	–	20	–	7	12	102
8.*D. rajasekari*	–	–	3	17	–	–	–	–	3	–	–	23
9. *D. takahashii*	28	19	43	–	18	14	–	9	21	23	24	199
10. '*D. hegdii*'	–	–	–	–	–	–	–	–	–	–	04	04
Total	187	109	209	100	135	142	104	112	121	118	126	1463
Subgenus *Drosophila*												
1. *D. immigrans*	28	18	38	28	14	15	–	18	14	14	19	206
2. *D. nasuta*	12	10	22	–	9	15	24	8	–	–	22	122
3. *D. paraimmigrans*	7	–	21	17	–	11	38	23	24	11	–	152
4. *D. repleta*	12	8	14	11	–	10	13	–	6	–	15	89
Total	59	36	95	56	23	51	75	49	44	25	56	569
Subgenus *Dorsilopha*												
1. *D. buskii*	22	3	7	–	19	11	24	22	–	13	–	121
Total	22	3	7	–	19	11	24	22	–	13	–	121
Subgenus *Scaptodrosophila*												
1. *D. nigra*	11	12	22	16	10	23	20	–	22	23	14	173
Total	11	12	22	16	10	23	20	–	22	23	14	173
Grand total	279	160	333	172	187	227	223	183	187	179	196	2326

Drosophila fauna of Kiphire

Total of 11 species were collected comprising of four subgenera viz. *Sophophora*, *Drosophila, Dorsilopha*, and *Scaptodrosophila*. Pooled data collected from Kiphire district has yielded a total of 160 individuals. Out of these 109 individuals (68.12%) belonged to 6 species of subgenus *Sophophora* (*D. bipectinata*, *D. kikkawai*, *D. malerkotliana*, *D. parvula*, *D. melanogaster*, and *D. takahashii*). 36 individuals (22.5%) belonged to 3 species of the subgenus *Drosophila* (*D. immigrans*, *D. nasuta*, and *D. repleta*). 3 individuals (1.87%) belonged to 1 species of subgenus *Dorsilopha* (*D. buskii*). The remaining 12 individuals (7.5%) belonged to 1 species of subgenus *Scaptodrosophila* (*D. nigra*).

Drosophila fauna at Kohima

Samples analyzed revealed a total of 15 species representing four subgenera, namely *Sophophora*, *Drosophila*, *Dorsilopha*, and *Scaptodrosophila*. Pooled data collected from Kohima yielded a total of 333 individuals. Out of these, 209 individuals (62.76%) belonged to 9 species of subgenus *Sophophora* (*D. bipectinata*, *D. eugracilis*, *D. jambulina*, *D. kikkawai*, *D. malerkotliana*, *D. parvula*, *D. melanogaster*, *D. rajasekari*, and *D. takahashii*). 95 individuals (28.52%) belonged to 4 species of the subgenus *Drosophila* (*D. immigrans*, *D. nasuta*, *D. paraimmigrans*, and *D. repleta*). 7 individuals (2.10%) belonged to 1 species of subgenus *Dorsilopha* (*D. buskii*).The remaining 22 individuals (6.60%) belonged to 1 species of subgenus *Scaptodrosophila* (*D. nigra*).

Drosophila fauna of Longleng

A total of 8 species were collected, belonging to three subgenera, namely *Sophophora*, *Drosophila*, and *Scaptodrosophila*. Pooled data collected from Longleng district yielded a total of 172 individuals. Out of these, 100 individuals (58.13%) belonged to 4 species of subgenus *Sophophora* (*D. eugracilis*, *D. malerkotliana*, *D. melanogaster*, and *D. rajasekari*). 56 individuals (32.55%) belonged to 3 species of the subgenus *Drosophila* (*D. immigrans*, *D. paraimmigrans*, and *D. repleta*). 16 individuals (9.30%) belonged to 1 species of subgenus *Scaptodrosophila* (*D. nigra*).

Drosophila fauna of Mokokchung

Total of 11 species were collected belonging to four subgenera namely, *Sophophora*, *Drosophila*, *Dorsilopha*, and *Scaptodrosophila*. Pooled data collected from Mokokchung district has yielded a total of 187 individuals. Out of these, 135 individuals (72.19%) belonged to 7 species of subgenus *Sophophora* (*D. bipectinata*, *D. eugracilis*, *D. jambulina*, *D. malerkotliana*, *D. parvula*, *D. melanogaster*, and *D. takahashii*). 23 individuals (12.29%) belonged to 2 species of the subgenus *Drosophila* (*D. immigrans* and *D. nasuta*). 19 individuals belonged to 1 species of subgenus *Dorsilopha* (*D. buskii*). 10 individuals (5.34%) belonged to 1 species of subgenus *Scaptodrosophila* (*D. nigra*).

Drosophila fauna at Mon

A survey of *Drosophila* fauna here yielded a total of 227 flies comprising 13 species representing four subgenera namely, *Sophophora*, *Drosophila*, *Dorsilopha*, and *Scaptodrosophila*. Out of these, 142 individuals (62.55%) belonged to 7 species of subgenus *Sophophora* (*D. eugracilis*, *D. jambulina*, *D. kikkawai*, *D. malerkotliana*, *D. parvula*, *D. melanogaster*, and *D. takahashii*). 51 individuals (22.46%) belonged to 4 species of the subgenus *Drosophila* (*D. immigrans*, *D. nasuta*, *D. paraimmigrans*, and *D. repleta*). 11 individuals (4.84%) belonged to 1 species of subgenus *Dorsilopha* (*D. buskii*). The remaining 23 individuals (10.13%) belonged to 1 species of subgenus *Scaptodrosophila* (*D. nigra*).

Drosophila fauna of Peren

Analysis of the sample revealed the presence of 10 species comprising four subgenera, namely *Sophophora*, *Drosophila*, *Dorsilopha*, and *Scaptodrosophila*. Pooled data collected from Peren district yielded a total of 223 individuals. Out of these, 104 individuals (46.63%) belonged to 5 species of subgenus *Sophophora* (*D. bipectinata*, *D. eugracilis*, *D. jambulina*, *D. malerkotliana*, and *D. parvula*). 75 individuals (33.63%) belonged to 3 species of the subgenus *Drosophila* (*D. nasuta*, *D. paraimmigrans*, and *D. repleta*). 24 individuals (10.76%) belonged to 1 species of subgenus *Dorsilopha* (*D. buskii*). The remaining 20 individuals (8.96%) belonged to 1 species of subgenus *Scaptodrosophila* (*D. nigra*).

Drosophila fauna of Phek

A total of 10 species were collected, comprising three subgenera, namely *Sophophora*, *Drosophila*, and *Dorsilopha*. Pooled data collected from Phek yielded a total of 183 individuals. Out of these, 112 individuals (61.20%) belonged to 6 species of subgenus *Sophophora* (*D. bipectinata*, *D. eugracilis*, *D. jambulina*, *D. kikkawai*, *D. melanogaster*, and *D. takahashii*). 49 individuals (26.77%) belonged to 3 species of the subgenus *Drosophila* (*D. immigrans*, *D. nasuta*, and *D. paraimmigrans*). 22 individuals (12.02%) belonged to 1 species of subgenus *Dorsilopha* (*D. buskii*).

Drosophila fauna of Tuensang

A total of 11 species were collected, belonging to three subgenera, namely *Sophophora*, *Drosophila*, and *Scaptodrosophila*. Pooled data collected from Tuensang district yielded a total of 187 individuals. Out of these, 121 individuals (32.35%) belonged to 7 species of subgenus *Sophophora* (*D. bipectinata*, *D. eugracilis*, *D. jambulina*, *D. kikkawai*, *D. malerkotliana*, *D. rajasekari*, and *D. takahashii*). 44 individuals (11.76%) belonged to 3 species of the subgenus *Drosophila* (*D. immigrans*, *D. paraimmigrans*, and *D. repleta*). 22 individuals (5.88%) belonged to 1 species of subgenus *Scaptodrosophila* (*D. nigra*).

Drosophila fauna of Wokha

Total of 11 species were collected, comprising four subgenera, namely *Sophophora*, *Drosophila*, *Dorsilopha*, and *Scaptodrosophila*. Pooled data collected from Wokha district yielded a total of 179 individuals. Out of these, 118 individuals (65.92%) belonged to 7 species of subgenus *Sophophora* (*D. bipectinata*, *D. eugracilis*, *D. jambulina*, *D. malerkotliana*, *D. parvula*, *D. melanogaster*, and *D. takahashii*). 25 individuals (13.96%) belonged to 2 species of the subgenus *Drosophila* (*D. immigrans* and *D. paraimmigrans*). 13 individuals (7.26%) belonged to 1 species of subgenus *Dorsilopha* (*D. buskii*). 23 individuals (12.84%) belonged to 1 species of subgenus *Scaptodrosophila* (*D. nigra*).

Drosophila fauna of Zunheboto

A total of 11 species were collected, belonging to three subgenera, namely *Sophophora*, *Drosophila*, and *Scaptodrosophila*. Pooled data collected from Zunheboto district yielded a total of 196 individuals. Out of these, 126 individuals (64.28%) belonged to 7 species of subgenus *Sophophora* (*D. bipectinata*, *D. hegdii*, *D. jambulina*, *D. kikkawai*, *D. parvula*, *D. melanogaster*, and *D. takahashii*). 56 individuals (28.57%) belonged to 3 species of the subgenus *Drosophila* (*D. immigrans*, *D. nasuta*, and *D. repleta*). 14 individuals (7.14%) belonged to 1 species of subgenus *Scaptodrosophila* (*D. nigra*).

Discussion

The abundance and taxonomy of *Drosophila* species collected in 11 district headquarters of Nagaland (including a recently described species *Drosophila hegdii*) was studied. Pooled data collected from 11 districts yielded a total of 2,326 individuals of subgenera *Sophophora*, *Drosophila*, *Dorsilopha*, and *Scaptodrosophila*. The subgenus S*ophophora* was represented by 10 species; subgenus *Drosophila* was represented by 4 species; subgenera *Dorsilopha* and *Scaptodrosophila* were represented by one species each. The study indicates that the *Drosophila* fauna of Nagaland is diverse.

The present study reveals the presence of *D. malerkotliana* in abundance. *D. malerkotliana* is considered to be sub-cosmopolitan and widespread in Southeast Asia, Borneo, West Malaysia, Australia, and several island groups in the Oriental region (Markow and O'Grady 2006). This species was reported in all previous collections made by multiple workers from north-eastern India (Achumi *et al.* 2013; Dwivedi and Gupta 1979; Gupta and Singh 1979, 1981a; Singh 1987; Yenisetti *et al.* 2002). This suggests that Nagaland's *Drosophila* diversity represents the confluence of South Asia and East Asia. Dominance of *D. malerkotliana* can be due to its ability to exploit diverse habitats.

D. bipectinata was found to be the second most dominant species in Nagaland. Literature review reveals that *D. bipectinata* is widespread in Kuala Lumpur, west Malaysia. This species is also widely distributed in Borneo, Philippines, Thailand, West Malaysia, Nepal, Japan, Taiwan, and India (Markow and O'Grady 2006).

In the present collection, the third most abundant species was *D. immigrans*, a cosmopolitan species found from Taiwan to Southeast Asia, Indonesia, India (Markow and O'Grady 2006). From their studies on *Drosophila* diversity of the Western Ghats, Ranganath and Krishnamurthy (1972) observed that *D. immigrans* is abundant at higher altitudes. The presence of *D. immigrans* in sub-Himalayan hilly regions supports this observation.

The present collection reports *Drosophila takahashii*, *D. parvula*, *D. nasuta*, *D. repleta*, *D. eugracilis*, *D. jambulina*, *D. kikkawai*, *D. rajasekari*, *D. nigra*, and *D. paraimmigrans* in Nagaland. *D. takahashii* is most widespread being found from India to Japan and into Micronesia; *D. parvula* is found from Southeast Asia, west Malaysia and Thailand; *D. nasuta* is thought to be from eastern Africa although this species has become widespread from South east Asia into Micronesia; *D. repleta* species is cosmopolitan in distribution; *D. eugracilis* is widespread in Indian subcontinent, found throughout Southeast Asia and into Australia; *D. jambulina* is widespread from India to southern China to Southeast Asia; *D. kikkawai* is circumtropical in distribution; *D. rajasekari* is found in India, Combodia, and Thailand; *D. nigra* is found in Australia, New Guinea, Borneo, Philippines, Malaysia, Thailand, and India; and *D. paraimmigrans* is found in India, Taiwan to Southeast Asia (Markow and O'Grady 2006).

Carson (1965) based on the pattern of distribution of various members of *Drosophila*, has recognized three distinct groups, namely 1) Virtually cosmopolitan species, 2) Species that are widespread but not cosmopolitan, and

3) Species having restricted distribution (endemic species). He included five species, namely, *D. melanogaster*, *D. simulans*, *D. ananassae*, *D. buskii*, and *D. repleta* as truly cosmopolitan. In the present study, *D. melanogaster*, *D. repleta*, and *D. buskii* were present. Though *Drosophila simulans* is cosmopolitan (Markow and O'Grady 2006), it was not found in any of the 11 sites in Nagaland. Contrarily, David *et al.* (2007) observed that *D. simulans* was absent from most of West Africa, very rare in the Cote d' Ivoire, and was absent in most parts of East Asia (David *et al.* 2007). Collections in Nagaland were made from wild localities. This can be the reason behind the absence of *D. ananassae* and *D. simulans*.

The striking observation in this study was that in all 11 study locations *Drosophila* species belonging to two subgenera, namely *Sophophora and Drosophila*, dominated in relative proportions of different species and their densities. This finding agrees with the observation of Bock and Wheeler (1972), who stated that in *Drosophila* collections made in any part of Southeast Asia or New Guinea, only two species groups comprise all or practically of all the catch, that is the *melanogaster* group of subgenus *Sophophora* and *immigrans* group of subgenus *Drosophila*. They further hypothesized that the *melanogaster* and *immigrans* species group might have originated in Southeast Asia and then colonized other regions. As Nagaland is a sub-Himalayan hilly state, which is a part of South Asia, the prevalence of subgenus *Sophophora* and *immigrans* species groups in the present collection reaffirms the observation made by Bock and Wheeler (1972).

The present study reveals that *Drosophila* fauna of Nagaland exhibits geographical convergence not only with South Asia but also with East Asia, which can be explained by the geographical location of this north-eastern state of India.

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18. PRESENT STATUS OF *ALDROVANDA VESICULOSA* L. IN INDIA

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Introduction

Aldrovanda vesiculosa L. is an insectivorous aquatic perennial herb, and an interesting flowering plant, due to its carnivorous habit. *Aldrovanda* L. is a monotypic genus (Aston 1982) belonging to family Droseraceae. The species was reported to be widely, but sparsely, distributed in Europe, tropical Africa, eastern and north-eastern India, Bangladesh, Japan, Timor, and Australia (Aston 1982; Tutin *et al.* 1964). Its Indian distribution was mostly localized in central Bengal and Salt Lake i.e., Bidhan Nagar areas in Kolkata (Clarke 1878; Prain 1903) and Manipur (Singh *et al.* 2000). The species was earlier recorded as 'vulnerable' in the context of the Indian region (Giri and Nayar 1983). According to the latest IUCN Red List, the status of the species is 'Endangered' (*cf.* The IUCN Red List of Threatened Species.Version 2015.2. www.iucnredlist.org. Downloaded on August 16, 2015). The present status of the species in India has been assessed in this article with remarks on its conservation.

Material and Methods

The specimens of *Aldrovanda vesiculosa* housed at CAL (Central National Herbarium, Howrah, India) were studied, and literature thoroughly consulted. The field observations of the author regarding occurrence of the species is based on survey in wetlands / waterbodies of eastern and north-eastern India, spanning three decades (Panda *et al.* 2009).

Aldrovanda can be distinguished from its closely related genus *Drosera* L., which also comprises carnivorous species, with the following key characteristics:

1. Leaves with sensitive hairs on trap-like lamina; lamina articulate; cauline leaves in whorls, vesicular; aquatic, planktonic, rootless herbs .... *Aldrovanda*
— Leaves bearing glandular hairs / tentacles; lamina not articulate; cauline leaves in basal rosette or alternate along the stem or absent; terrestrial, rooted herbs .... *Drosera*

Aldrovanda vesiculosa L., Sp. Pl. 1: 281. 1753; DC., Prodr. 1: 319. 1825; C.B. Clarke in Hook. f., Fl. Brit. India 2: 425. 1878; Deb in Bull. Bot. Surv. India 3: 327. 1961; Chauhan in Singh *et al.*, Fl. Manipur 1: 373. 2000. Syn.: *A. verticillata* Roxb., Fl. Ind. 2: 112. 1832.

Common names: English – Waterbug Trap, Waterwheel Plant; Bengali – *Malacca Jhangi*.

Small aquatic herb, free-floating to submerged, rootless, succulent, perennial; insectivorous / carnivorous. Stem articulate with whorls of spatulate-orbicular leaves at nodes, irregularly branched. Leaves in crowded whorls of 5–9, 6–18 mm long, each leaf with a cuneate basal part and terminating in 4–7 bristles and an orbicular lobe, hinged along midrib, which can close rapidly to entrap and digest small insects. Flowers axillary, solitary, emergent, shortly stalked / peduncled, peduncles decurved in fruit; bracts absent. Calyx 5-partite, lobes ovate, 3–4 mm long, imbricate. Petals 5, greenish white or tinged pink, narrowly obovate, 4–5 mm long, hypogynous, connivent in a cap. Stamens 5, almost as long as sepals, hypogynous; filaments filiform-subulate; anthers bilobed, dehisce laterally. Carpels 5, connate in unilocular subglobose ovary, placentation parietal, ovules numerous; styles 5, filiform, free, spreading, each with terminally branched and fringed stigmas. Fruit subglobose capsule, 5-valved, membranous, *c.* 4 mm long, *c.* 3 mm wide, ripening underwater; seeds many, rarely few (6–8), oblong to broadly ellipsoidal, *c.* 1.5 mm long, with a short thick basal foot, testa blackish, shiny.

Flowering & Fruiting: August to September.

Pollination: Flowers emergent or submerged, entomophilous or autogamous, usually cleistogamous.

Perennation: The disseminules are seeds or turions (specialized apical buds).

Earlier distribution in India: Salt-pans in south of Calcutta (now Kolkata) in West Bengal (Clarke 1878), and Imphal in Manipur (Singh *et al.* 2000).

World distribution: Central and southern Europe and southwest former U.S.S.R., Japan and adjacent portions of Manchuria and U.S.S.R., tropical Africa, Bangladesh, Timor, and northern Australia (Aston 1982; Tutin *et al.* 1964).

Ecology: The plant usually occurs in shallow, still fresh water, floating or often caught on submerged vegetation below the water surface, usually found among reeds, sparse or in tangled masses. It was recorded as a 'water-weed' in erstwhile Bengal (Prain 1903).

Specimens examined: Specimens in the CAL herbarium: 1. Lower Bengal, Salt Pans near nullah, November 1869, *S. Kurz*, s.n. Acc. No. 161085; 2. Salt Lakes – margins near the southern side of Calcutta – floating in small clumps, July 12, 1914, *M.S. Ramaswami*, 187; 3. Jhils (fresh water lakes), south of Calcutta, November 10, 1955, Collector not known, Acc. No. 161084. 4. Bangladesh: collected between Tarpassa and Boloi, Vikrampur, Dacca, on August 07, 1936, by J.C. Sen Gupta, Acc. No. 161086, and annotated as "found growing near the surface of water on submerged rice fields, associated with Utricularias, Myriophyllums, *Hygrorhiza aristata* and other aquatic plants".

Among the newer floras, the species was reported only from Imphal in Manipur – a north-eastern state (Singh *et al.* 2000). There is no mention of the species in the RED DATA BOOK OF INDIAN PLANTS (Nayar and Sastry 1987, 1988, 1990).

The availability of only three herbarium specimens of *A. vesiculosa* from India at CAL indicates that this species has not been collected after 1955. Cook (1996), while working on the aquatic and wetland plants of India, commented that *A. vesiculosa* has been reported as extinct in Salt Lake near Calcutta. The present author, while exploring macrophytic vegetation in the wetlands of West Bengal, did not sight a single plant (Panda *et al.* 2009). The herbarium, literature, and field study reveal that the species has probably disappeared from the Indian region.

Considering its wide general distribution vis-à-vis a localized distribution in India, it is likely that it was introduced in the neighbourhood of Calcutta, the capital of India during the colonial period. *A. vesiculosa* has probably disappeared from India due to change in its natural habitat and imposed threats, which mainly include practice of aquaculture / pisciculture and reclamation / conversion for cultivation apart from infestation of *Eichhornia crassipes* (Mart.) Solms. and siltation from run-offs, besides regular retting of jute in some waterbodies.

It is assumed that the rarity of a species in herbaria indicates under-exploration and not extinction or otherwise. But in case of *A. vesiculosa*, the inference has been drawn from the author's findings in the field, and study of literature and herbaria specimens spanning over three decades. The question of under-exploration or an oversight to record the species can therefore be ruled out in this case.

The author, therefore, strongly recommends the propagation of this species in its natural habitat (shallow freshwater) in the country, possibly through germplasm and *in vitro* tissue culture / micro-propagation techniques. Conservation of wetlands, the natural habitat of the species, becomes all the more imperative.

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19. ON THE ECOLOGY AND OCCURRENCE OF *AEGINETIA INDICA* L. AND *WRIGHTIA DOLICHOCARPA* BAHADUR ET BENNET IN SOUTHERN GUJARAT, INDIA

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Southern Gujarat includes four districts, namely Surat, Valsad, Navsari, and Dangs. Of these, the Dangs forest receives heavy rainfall and is rich in plant diversity. The Saputara Hills are considered as an offshoot of the Western

Ghats. During a plant diversity survey of southern Gujarat, we recorded two plant taxa, *Aeginetia indica* L., and *Wrightia dolichocarpa* Bahadur et Bennet.

Systematic Enumeration

Aeginetia indica L. (Orobanchaceae)

Taxonomic Identity: A small, ephemeral, leafless, parasitic herb. Stem weak and tinged purple. Flowers pinkish-purple, solitary on top of naked scape. Capsules ovoid, beaked, enclosed in the persistent calyx and corolla. Seeds pale-yellow, testa loose and hyaline.

Flowering and Fruiting: August–October.

Location of specimen: Pindval in Dharampur forest of the district Dangs in southern Gujarat.

Ecology: This species was found in association with litter of bamboo thicket on well-mulched ground and under dense shade.

Threats: Loss of habitat and removal of mulch.

Remarks: Rare. There are only three species of the genus *Aeginetia* in tropical and subtropical Asia, two of which are found in India. *A. indica* is habitat specific; its possible habitats are mulched and rotten litter, in dense shady areas. This species may occur in other areas of southern Gujarat.

Wrightia dolichocarpa Bahadur et Bennet (Apocynaceae)

Taxonomic Identity: A tall tree. Leaves opposite with milky latex. Flowers white. Follicles *c.* 65–95 cm long, dark green. *Wrightia dolichocarpa* is closely associated with *Wrightia tinctoria*, but differs from the latter in having leaves dark green and follicles more than 65 cm long while in *W. tinctoria* leaves are light green and follicles are *c.* 65 cm long.

Flowering and Fruiting: February–June.

Location of specimen: Nibarpada near Saputara in southern Gujarat.

Ecology: Found only once along river bank in association with *Wrightia tinctoria* in dense forest on low hilly areas.

Present Status: Very rare.

Remarks: There are three species of Genus *Wrightia* in India, namely *W. tinctoria*, *W. tomentosa* (Syn. *W. arborea*), and *W. dolichocarpa*. *Wrightia dolichocarpa* was earlier reported only from Goa, where its status was endemic and rare. It has also been recently recorded from Daman and Diu. This species is included in the IUCN Red List of Threatened Plants 1997 (Walter and Gillett 1997). The present report is a range extension of the species.

REFERENCE

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20. *CROTON HIRTUS* L'HERIT. (EUPHORBIACEAE) – A NEW RECORD FOR KARNATAKA, INDIA

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The genus *Croton* L., consisting of about 800–1,200 species (Mabberley 2009), is distributed in the tropics and subtropics of the Old and New World. Of these, 16 species have been reported from India (Chakrabarty and Balakrishnan 2012). This includes two exotic species, namely *Croton bonplandianus* Baill. and *C. hirtus* L' Herit., introduced from tropical America. *C. bonplandianus* is widespread and common throughout India, while *C. hirtus* has been reported only from Tamil Nadu and Kerala (Chakrabarty and Balakrishnan 2012) till now. In Karnataka, genus *Croton* is represented by 10 species (Saldanha 1996). During a field trip in Kundapur taluka of Udupi district (Karnataka), the author noticed *C. hirtus* growing by the roadside along National Highway 66 in Kumbhashi. The present collection of *C. hirtus*, therefore, forms a new record for Karnataka. It is presumed that this species may occur in many more places in coastal Karnataka and is likely to become widespread in southern India. This species is closely allied to *C. bonplandianus*, but differs in having broadly ovate-lanceolate leaves and stalked capitate-glandular hairs in the rachis of the inflorescence.

A brief description of the taxon is provided below for identification.

Croton hirtus L'Herit., Stirp. Nov. 17, t. 9. 1785; V.S. Ramach. *et al.* in Indian J. Forest. 15(2): 183, f. 1. 1992. *C. glandulosus* L. var. *hirtus* (L'Herit.) Muell.Arg. in DC., Prodr. 15, 2: 684. 1866; Chakrab. & Balakr. in Fl. India 23: 234. 2012.

Annual erect herb, up to 60 cm high; stem branched, retrorsely stellate-hispid. Leaves alternate, opposite or whorled in the region of branching; lamina 2.5–6 × 2–5.5 cm, broadly ovate-lanceolate or triangular-ovate, with a pair of stalked glands at base, membranous, rounded, obtuse to subtruncate at base, margins doubly crenate-serrate, acute at apex, sparsely strigose above, densely stellate-hairy beneath, 3–5-veined from base; petiole up to 4 cm long; stipules filiform, stellate-hispid. Inflorescence terminal, 1.5–5 cm long, racemose, male flowers at the top and female at base; rachis hirsute with branched capitate glands towards base; bracts linear-lanceolate, capitate-glandular with *c.* 4 slender, stalked, ellipsoid glands with stalks up to 5 mm long. Male flowers: pedicels *c.* 1 mm long; sepals 5, 1.0–1.5 mm long, hispid; petals 5, white, spatulate, equaling sepals; stamens usually 11, filaments and anthers white. Female flowers: pedicels *c.* 0.5 mm long; sepals 4–5, 4–5 mm long, unequal, green, narrowly oblanceolate; petals usually absent; ovary globose, densely hirsute, 3-celled, with one ovule in each cell; styles 3, *c.* 2 mm long, bifid into linear branches. Fruit capsular, *c.* 4 mm in diam., subglobose, stellate-hispid, 3-seeded. Seeds 2.5–3 × 2 mm, ovoid, greyish-brown, carunculate.

Flowering & Fruiting: August–September.

Distribution: Native to West Indies, C. & S. America, but becoming naturalized in tropical Africa and Asia.

Specimen examined: INDIA: Karnataka, Udupi district, Kumbhashi, *c.* 9 km south of Kundapur, 24.viii.2014, K.G. Bhat 11448 (MH).

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21. *ELEOCHARIS SPIRALIS* (ROTTB.) ROEM. & SCHULT. (CYPERACEAE) – A NEW RECORD FOR ANDAMAN AND NICOBAR ISLANDS, INDIA

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Introduction

During a floristic survey of Andaman and Nicobar Islands in 2014, we collected some specimens of *Eleocharis* R. Br. On examination of relevant literature and critical analysis of nut morphology (Cook 1996; Hooker 1893; Koyama 1985; Prasad and Singh 2002), the identity of the species was determined as *Eleocharis spiralis* (Rottb.) Roem. & Schult. A thorough literature survey (Pandey and Diwakar 2008; Vasudeva Rao 1986) revealed that this species has, so far, not been recorded from Andaman and Nicobar Is. Hence, it is reported here as a new record for Andaman and Nicobar Is.

Eleocharis spiralis (Rottb.) Roem. & Schult., Syst. Veg. 2: 155. 1817; Clarke, Hook. f., Fl. Brit. India 6: 627. 1893; Koyama, Dassanayake & Fosberg, Rev. Handb. Fl. Ceylon 5: 257. 1985. C.D.K. Cook, Aquat. Wetl. Pl. India 130, f. 126 a-d. 1996. *Scirpus spiralis* Rottb., Descr. & Ic. 45, t. 15, f. 1. 1773.

Perennial herb with short rhizome; scaly stolons 4–13 cm long and *c.* 3 mm thick. Culms densely tufted, erect, triquetrous, gradually narrowing to an acute apex, 25–65 cm tall, 2–4 mm in diameter, deep green, smooth, shiny, not septate. Sheath 2–3, membranous, pale green, becoming purple-red above, oblique at mouth. Spikelet cylindrical, slightly broader than apex of the stem, 1.5–3.5 cm long and 3–6 mm in diameter. Glumes tightly and spirally arranged, imbricate, suborbicular to broadly ovate, truncate at apex and cuneate at base *c.* 3 x 3 mm distinctly brown spotted towards the centre and scarious towards margins. Stamens 3. Perianth bristles 4–6, unequal, smooth, from much shorter than to as long as the nut. Style *c.* 1.8 mm long, 2–3 cleft; style base pyramidal. Nut biconvex, obovoid to oval *c.* 1.7 mm long and *c.* 1.3 mm in diameter, glossy, straw-coloured becoming deep brown to black later, longitudinally striate with *c.* 18 rows of cells, without neck and apical annulus.

Flowering & Fruiting: September–January.

Habitat: Grows in ponds with shallow brackish water along the margin of estuaries and sea shore, in association with *Ceratopteris* sp. and *Eleocharis dulcis* (Burm. f.) Trin. ex Hensch.

Distribution in India: Kerala, Karnataka, Maharashtra, Tamil Nadu, West Bengal, and Andaman and Nicobar Islands.

Specimens Examined: INDIA: Andaman and Nicobar Islands: Burmanala on way to Chidia Tapu (South Andaman), 11.i.2014, A.N. Chandore 1851 (SUK); Sippighat, South Andaman, 12.i.2014, M.Y. Kamble 30973 (PBL); Maharashtra: Ratnagiri district, Rajapur tehsil, Burambe lake near estuary of Sagave-Shirse village, 08.xii.2013, A.N. Chandore 1838 (SUK).

Note: *Eleocharis spiralis* (Rottb.) Roem. & Schult. can be easily identified by its triquetrous stem that gradually narrows towards the apex, and glumes tightly and spirally arranged, imbricate, suborbicular to broadly ovate, truncate at apex and cuneate at base.

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CONTENTS

EDITORIAL 159

REOCCUPATION OF FORMER TERRITORIES BY THE ASIATIC LION *PANTHERA LEO PERSICA*, MEYER, 1826, IN SOUTHERN SAURASHTRA, GUJARAT, INDIA: A VISION FOR FUTURE MANAGEMENT
M.K. Ranjitsinh 161

BEHAVIOURAL ETHOGRAM OF SPOTTED OWLET *ATHENE BRAMA* (TEMMINCK, 1821)
Ashish N. Nerlekar, Gaurang G. Gowande and Pratik S. Joshi 172

TAXONOMIC STUDIES ON THE GRASSHOPPER FAUNA (ORTHOPTERA: ACRIDIDAE) RECORDED FROM PADDY FIELDS IN UTTAR PRADESH, INDIA
Md Humayoon Akhtar and Mohd Kamil Usmani 180

A REPORT OF EREBIDAE (LEPIDOPTERA: NOCTUOIDEA) FROM THE TAMIL NADU PART OF THE WESTERN GHATS, INDIA
K. Sivasankaran and S. Ignacimuthu 193

REVIEWS 210

MISCELLANEOUS NOTES 212

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